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PRESTWICH AND PRACTICAL GEOLOGY.

Life and Letters of Sir Joseph Prestwich. Written and edited by his Wife. Pp. xiv+444. (Edinburgh and London: Wm. Blackwood and Sons, 1899.)

THIS is a pleasantly written personal history of a well-known man, and as such interesting to his friends who survive him and to the numerous friends of his friends who have passed away but are spoken of in connection with him. Scientific inquiry, however, filled so large a part of his life, and he did so much for the elucidation of certain branches of geological inquiry, that the story cannot fail to be more or less an account of the progress of research along those lines to which he devoted himself.

Born of a good north-country stock, Prestwich was sent to school while very young, and although people took a fancy to the spirited boy and were kind to him, he must have had to rough it somewhat in childhood. At sixteen he entered at University College, London, where he worked hard and successfully, but confined his attention, unwisely as he allowed in after life, too much to chemistry and natural philosophy to the neglect of mathematics and classics.

Yet it must not be supposed that he was a one-sided man, for he carefully apportioned his time when it was more at his own disposal, and went through a very full if not severe training. His extensive reading in English literature and his knowledge of the French language, acquired when a boy at school in France, and kept up in after life, proved of the greatest assistance to him. Joseph Prestwich, jun., was soon well known in the scientific world, and those social qualities and that genial temperament which made "Uncle Jovis' parties" so delightful to the happy children he loved to gather round him, enabled him also to do much to further the co-operation of scientific workers, and "Prestwich's Easter excursions" were not less highly appreciated by the geologists who had the privilege of joining them.

These excursions were certainly very pleasant and profitable. They were thoughtfully planned and well-managed. The party, generally consisting of one carriage load, met at some appointed spot. A few put their heads together when invited by the leader to do so, details were arranged, orders as to hours were given—these often involving a very early start—a call all round for say 10*l.*, which was carefully administered till spent, when a new call was made, then from each halting-place visits to points of interest, examination, discussion, demonstration, and home to dinner.

Among the illustrations in the book are excellent portraits of some of his more intimate friends, most of whom at one time or another accompanied him on his geological excursions.

He had for forty years to give most of his time and attention to business, but all his hours of leisure were spent and all his recreation taken in the pursuit of his favourite subject geology.

In his reply to the remarks which Sir Henry De la Beche made on presenting the Wollaston medal to him in 1849, he said:

"It is true that I entered upon this field as a student and for relaxation, but the interest and difficulties of the subject speedily induced me to take it up with more earnestness and determination, and eventually led me to extend the inquiry over an area which I, at first, never contemplated.

"The Tertiary geology of the neighbourhood of London may be wanting in beauty of stratigraphical exhibition and in perfect preservation of organic types, but in many of the higher questions of pure geology—in clear evidence of remarkable physical changes, in curious and diversified palæontological data, however defaced the inscriptions, which is after all but a secondary point—few departments of geology offer, I think, greater attractions.

"The pleasure I have derived from the study of the remarkable phenomena which have come before me in the course of the investigation has far outbalanced the few obstacles I have had to contend against. I, in fact, feel deeply indebted to geology, as a source of healthful recreation, as an inestimable relief and abstraction in due season from the cares frequently attendant upon the active duties of life, for its kindly and valued associations, and above all for the high communing into which it constantly brings us in the contemplation of some of the most beautiful and wonderful works of the creation" (p. 66).

Yet most of his work, undertaken and carried on in the true scientific spirit, bore directly, as it turned out, on questions of the greatest economic importance. This was, however, by accident, for he studied the Coal Measures in early life only because his holidays were spent at Broseley, where he got interested in the geology of Coalbrook Dale. And similarly the Tertiary and Cretaceous rocks of the London district offered in later life the most accessible sections, and so he plunged with his usual zeal into their discrimination and classification with no ulterior view to the practical application of the information he was then acquiring. But the knowledge which he gained of the characters and sequence of both these groups of formations was afterwards of immense value to the country, and we find him not only a member of the Coal Commission, but also one of the most trusted authorities on water-bearing strata.

His paper on Coalbrook Dale is a masterly sketch in which the fossils of different horizons are distinguished and the stratigraphical structure of the district is worked out with great accuracy and well illustrated by maps and sections.

To give an idea of his work on the Tertiary strata would be to give a sketch of Tertiary geology which is not wanted in a notice of this kind, for he established the classification which is now adopted with very slight modification.

He followed up the strata to the newest beds, and soon took part in the discussions which arose respecting the age and origin of the Glacial and post-Glacial deposits—controversies not yet settled, and inquiries out of which suggestions of new difficulties yet to be explained still continue to arise.

It is very interesting to follow the progress of opinion respecting the association of the remains of man with those of extinct animals in the river gravels, whose antiquity was further proved by their relation to the

physical geography of the country. There were doubts also as to the objects from the occurrence of which the presence of man was inferred, for, except in some very doubtful instances, it was not his bones that were found, but only flints roughly fashioned into serviceable instruments. A good sketch of the development of the inquiry appeared some years ago in *Blackwood's Magazine* (vol. clvii., June 1895, p. 939).

M. Boucher de Perthes had conceived the idea that so it must be, but it was long before he found sufficiently convincing evidence of the fact. At last, however, after Boucher de Perthes had been excavating, collecting, talking, and writing about it for years, Dr. Falconer visited him and acknowledged that a good *primâ facie* case had been made out, and wrote to Prestwich to say that he ought to look into it. Prestwich accordingly made a pilgrimage to Abbeville, and came to the conclusion that there were in Boucher de Perthes' collection flints which had undoubtedly been wrought by man, which had been found in undisturbed ground, and which were of the same age as the remains of the extinct mammalia found with them.

Boucher de Perthes supported a good theory with much bad evidence, and we must bear in mind from all that passed then that there is need for caution in disbelief as well as in belief, and it may be that Prestwich's conviction may prove well-founded, that in the plateau gravels of Kent and Wiltshire there are flints worked by man of much earlier date than the palæolithic implements the genuineness of which he had with so much skill and pertinacity established. At present, however, the evidence as to these Palæotaliths or Eoliths, as they have been called, is not quite satisfactory, for natural forms have been exhibited with too much confidence as the work of man.

The view that there has been a great submergence of our island since glacial times will probably turn out to be correct, though it may be that the lapse of time over which it extended has not been rightly estimated. But the opinion that the phenomena could be best explained by submergence of such a transitory and tumultuous nature as to be properly called a flood will not at present command general acceptance. Prestwich himself seems to have been willing to qualify very considerably the statements involving the idea of a flood.

In endeavouring to interpret the story of the later accumulations it was, of course, most desirable to search for any local conditions which tended to preserve the relics which were chiefly relied upon as evidence, and such conditions appear to be furnished by the caves in which are found sealed up the remains of man who lived or buried his dead there, of the wild beasts which crawled in to die, or dragged in the bones of other dead animals to feed upon at their leisure.

Prestwich therefore paid much attention to the hyæna dens and other caves discovered from time to time round the coast or in inland cliffs. His object was to establish some chronology from the associated objects, or make out certainly any relation between the contents of the caves and of the raised beaches or river terraces which were by degrees beginning to be understood.

Prestwich was so impressed by the vastness of the changes which had taken place even during the latest geological ages that he began to doubt whether the operations of nature which we see going on around us were sufficient to bring about such great results, and he further saw evidence of more violent action in many of the phenomena of recent date. While not reviving the old cataclysmic views, he questioned the wide application of the uniformitarian doctrines as taught by Lyell; but their views will be easily reconciled, first, by the doctrine that local catastrophic action is quite consistent with continuity of causation; and, secondly, by the admission of the inevitable effects of ever-recurring earth movements in hurrying up or retarding the operations of denudation and deposition.

The theory that there exists an underground plateau of Palæozoic rocks extending at an inconsiderable depth beneath the Secondary and Tertiary rocks of East Anglia, interfering as at Ware with the water supply, and raising hopes everywhere of a new source of coal supply, which was partly suggested by De la Beche and put into shape by Godwin Austen, and which was verified at Harwich, Ware, London and Dover, was, of course, a subject of the greatest interest to Prestwich, and the progress of the investigation was largely advanced by him.

He was a pleasant letter writer, but as time went on he seems to have confined himself more and more to the object for which he had taken up his pen, and that was generally some scientific point. His sense of humour was strong, but showed itself more in conversation than in his letters.

At his pleasant home on the chalk hills he spent many happy days in later life, and there he breathed his last soon after Royal favour had recognised his long services by designating him as one of the recipients of the honours granted on New Year's Day 1896.

His memoir is written in a loving spirit, and there will be few amongst its readers who do not entertain towards him that affectionate feeling of regard and respect that would be very ill content with any other treatment.

METEOROLOGY, OLD AND NEW.

Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus. Herausgegeben von Prof. Dr. G. Hellmann. Wetterprognosen und Wetterberichte des xv. und xvi. Jahrhunderts. (Berlin: Asher and Co., 1899.)

Annals of the Astronomical Observatory of Harvard College. Vol. xxxix. Pp. iv + 153. Part I. Peruvian Meteorology, 1888–1890. Compiled and prepared for publication by Solon I. Bailey, Assistant Professor of Astronomy, under the direction of Prof. E. C. Pickering. (Cambridge, U.S., 1899.)

Annales de l'Observatoire national d'Athènes publiées. Par Démétrius Éginitis, Directeur de l'Observatoire. Tome I. Pp. xxi + 395. (Athènes: Imprimerie Nationale, 1898.)

DR. HELLMANN has devoted himself with indefatigable application to the unearthing of those rare publications which illustrate the growth of an intelligent interest in the sciences of meteorology and magnetism, when these subjects first attracted attention

after the period of the Renaissance. Our columns have from time to time borne witness to his energy and to the merit of his selections. The present volume constitutes the twelfth of the series, and in matter of interest is not one whit behind any of its predecessors; while the beauty and fidelity of the facsimile reproductions will be acknowledged on all hands. In a short preface, Prof. Hellmann sketches the growth of the popularity of treatises on weather prediction, which circulated in great numbers before the close of the fifteenth century, whether in the form of almanacs or works of even greater pretension. The substitution of the language of the country for the learned Latin, which was in more general use prior to 1470, gave a great stimulus to the circulation, and on the continent of Europe these pamphlets and broadsheets won for themselves a warm welcome. Of the remains of this large harvest which have come down to us, Prof. Hellmann offers some typical selections, accurately reproduced as they circulated from hand to hand among various nationalities. Italy seems to have been earliest in the field to minister to the popular longing for this kind of literature, but later had to give way to German perseverance, which has won for itself the doubtful reputation of producing the greatest number of these almanacs. Prof. Hellmann has already given a catalogue of 600 distinct publications, but later study has made him acquainted with many more, and he now places the number at not less than 750. England and France, judged by the number of examples that have been preserved, do not seem to have exhibited anything like the same eagerness for the possession of this kind of writing which Germany, Italy, and the Netherlands exhibited. But specimens of all these various productions, graduated in point of time throughout the sixteenth century, are now made accessible to the student. England is represented by "An Almanacke and Prognostication" for 1555, by A. Aksham, priest and physician, which in the main outline differs but little from much earlier productions. An excellent example, dated 1506, due to the fancy of Leonardo de Richi, is presented in facsimile. As a rule it may be said that these various prophecies and indications begin with a dedication to some notability, then follow predictions relating to fruitfulness, conditions of health, wars and peace, in which is prefigured the fate of nobles and States, and towns and countries, and finally the times of moon changes are added, a knowledge of which is not only necessary for predicting the weather, but indicate the proper times for blood-letting and surgical operations. A modest section suffices for indicating the variations of the weather. We may quote an example from the Prognosticon of Julian de Blanchi which relates to October: "October ventosus et in eo aquae et tonitrua apparebunt, et dies dispositi ad aliquam aeris alterationem erunt iii., v., vii., xiii., xx., xxii., xxvi., xxxi."

The second volume quoted above refers mainly to an inquiry into the climate of Peru, but possesses a feature of distinct interest, to which we shall refer later. Peru has been roughly but conveniently divided into three regions, marked by the peculiarities of coast, mountain and forest climate. More particularly in two of these different localities, the enterprise of Prof. Pickering has established fully equipped meteorological observatories, and the present volume contains the discussion of the measures made at these stations between 1888-90. Mollendo, nearest the coast, is situated on the narrow strip of rock and sand which marks the abrupt rise of the continent from the waters of the Pacific. Chosica, further inland, is about twenty-five miles north-east of Lima. Here the climatic conditions fall midway between those of coast and mountain; for the land rises gradually from the ocean in successive ranges, each higher than that preceding it. The station itself stands on the summit of a conical mountain some 7000 feet high. Vincocaya and Puno, the two remaining stations in actual working order, are distinctly of the mountains. The former is near the crest of the Western Cordillera, on a desolate plateau nearly 15,000 feet in elevation. Puno is on the western shore of Lake Titicaca, and is typical of the great plateau which lies between the Western Cordillera and the Bolivian Andes. A few observations were also made at Pampa Central, near the central western part of the great desert of Atacama. Prof. Pickering describes this region as possibly the most barren on the earth. Not even a cactus breaks the monotony of the view near this town. The ground is rich in nitrates and other salts of immense commercial value; but the absence of rain on a soil of this character makes the region absolutely barren. In districts so uninviting and remote from the conveniences of civilisation, observers are found who, often without any hope of pecuniary reward, devote themselves to the maintenance of a continuous meteorological record. Self-registering apparatus is sometimes used, but the monotonous registration of the amount and character of cloud and similar data which go to decide the climate of a country, can only be secured by regular personal supervision; and though Prof. Pickering is obliged to reject some of the observations, owing to a suspicion of error, we think he is to be congratulated on securing an amount of co-operation which could hardly be anticipated in so inhospitable a country.

But the feature of special interest, and one that gives to the volume something of the charm that attaches to a work on travel, is the description of the establishment of two meteorological observatories near the summit of the lofty El Misti, a mountain which dominates the city of Arequipa, and from its symmetry, height and proximity constitutes the most imposing feature in the range of mountains that nearly encircles that town. It goes without saying that the approach to the summit is attended with great difficulties; but, rising as it does to a height of some 20,000 feet, or about 12,000 feet above the elevated plateau on which Arequipa stands, this truncated cone offers advantages to the meteorologist intent on studying the behaviour of the atmosphere at considerable elevations not less than the clear skies of Arequipa present to the practical astronomer. But only the most energetic would suggest to themselves the possibility of pursuing meteorological observations in a spot so inaccessible. Prof. Bailey gives us some account of earlier attempts, made at rare intervals, to reach the top of this venerated peak, some undertaken for the benefit of science, some from curiosity, but all, whether successful or not, accompanied with considerable danger and fatigue. Yet an observatory to be useful must be regularly and systematically visited. A tolerably

permanent mule track seemed to Prof. Bailey the best and only means of reducing the hardship of the ascent, and with true American ingenuity and enterprise he undertook the task of making a passable road up the sides of this barren mountain, over the remains of ancient lava streams and past huge slopes of volcanic sand, whose angle of ascent was oftentimes as much as 30°. Indians and Spaniards alike ridiculed the attempt, but Prof. Bailey persevered with his design, in spite of fatigue, mountain sickness, sulphurous vapours and the yielding character of the ground, into which the feet of the mules would sink six inches at each step. How he finally succeeded is modestly described in a chapter of great interest, to which we must refer for particulars. We can only record that at an altitude of 15,000 feet, approximately that of Mont Blanc, but in this latitude beneath the line of perpetual snow, the first observatory hut was set up, and, cheered by this success, it was resolved to attack the summit of the crater, and now eight feet above the highest point of the mountain a Robinson anemometer is successfully mounted, giving a continuous record of wind velocities in this elevated region. Other instruments from which records are obtained are a Richard self-registering hygrometer and thermograph, which register continually for ten days without interruption. Special thermometers and apparatus are mounted in a hut six feet square and seven feet high, on the very top of the mountain, a monument of well-directed vigour and indomitable resolution on the part of the director. We can but offer our congratulation on the completion of a work of so much difficulty, and hope that the results will equal in interest the labour by which they have been secured. Whatever may be the final outcome of mountain meteorology, Prof. Pickering has definiteiy secured, through the untiring efforts of Prof. Bailey, a chain of meteorological stations from Mollendo on the Pacific to the headwaters of the Amazon.

We have, unfortunately, but little space to do justice to the work of M. Éginitis. A thick volume filled mainly with meteorological observations and their discussion is apt to prove somewhat wearisome reading, but the director has managed to introduce some features of interest. In fact, the publication of the volume itself, indicating as it does the renewed activity of an observatory which has been practically non-existent since the death of Dr. J. F. Julius Schmidt, cannot but be welcome, and we may venture to hope that the observatory from which so much valuable work has emanated in the past will again be found among the institutions that contribute to the progress of science. M. Éginitis gives in an interesting chapter the history of the observatory since its erection, a record which in spite of sundry interruptions should prove inspiriting, since it demonstrates that the energy and ability of successive directors have risen superior to the difficulties inseparable from small instruments and straitened means. The volume is divided into two parts ; in the first the climate of Athens is discussed, the treatise being enlivened by the introduction of many extracts from the old classical authors. In the second part are given the readings of the various instruments, by the discussion of which the climate is determined.

W. E. P.

MACHINES FOR THE LIQUEFACTION OF GASES.

Liquid Air and the Liquefaction of Gases. By T. O'Conor Sloane, Ph.D. Pp. 365. (London : Sampson Low, Marston, and Co., Ltd., 1899.)

THIS book may be regarded from three points of view : (1) as a popular account of recent work and experiments ; (2) as a scientific examination of the same ; and (3) as a historical summary and appreciation of invention in a special branch of science. As an instalment of popular science it has much interest. Readers who, guiltless of any exact science themselves, like to know what is going on in the modern scientific world, will find here a good deal that will help them to understand the significance of such steps in advance as are from time to time reported. As an exact critique of the progress of invention it is not a success. On p. 300, for instance, Dr. Sloane says : "The origin of the methods used by Tripler, Hampson and Linde can be studied in the records of the Patent Offices." Then referring to Mr. Tripler's patent of 1893, he says the apparatus therein described "is based on self-intensification for the production of cold. The Joule-Thomson effect is not appealed to in it." Shortly afterwards he says : "Linde and Hampson have both invoked" the Joule-Thomson effect "as the principle on which their machines operate." The teaching here, that, whereas the initial cooling in the Linde and Hampson machines is identical with the Joule-Thomson effect, it is in the Tripler machine produced in some other way, is entirely without justification and contrary both to good science and to common sense. The machines are all three based on the Joule-Thomson effect, and all three involve the use of self-intensification, while neither of these means is applied in Mr. Tripler's 1893 patent. More astonishing still, if Dr. Sloane is to be regarded as a scientific writer, are his approving references to this patent (its number, which he does not give, is 4210). This patent Dr. Sloane accepts as giving "a clear description with drawings" of a self-intensive refrigerator from which Mr. Tripler's present apparatus is derived. The apparatus is not a refrigerator at all, for it contains a fatal fallacy, the omission of cooling coils after the pump, to remove the heat of compression ; while the circuit is so arranged that for liquefying air no such coils could be introduced. The apparatus therefore, designed to produce cold, is a generator of heat. Secondly, even if it produced initial cooling, as expected, such cooling could never be intensified, since there is no self-intensive interchanger. An interchanger, to make the cooling effectively self-intensive, must have one end at the higher temperature, where the compressed air enters, the other end, where this air expands, at the extremely low temperature, and a continuous gradation of temperatures between them. In Mr. Tripler's patent there is no interchanger in which such an arrangement is possible. Again, on p. 295, Dr. Sloane praises Mr. Tripler's apparatus for its extreme simplicity, as using no refrigerant ; and after describing Dr. Linde's more complex laboratory system, with its preliminary refrigeration by ice and salt, he says, on p. 320, that the Hampson

and Linde systems are very similar, and work "precisely on the same lines." The truth is that the Linde apparatus works with air at three pressures, uses preliminary refrigeration by ice and salt, has widely coiled helices consisting of three pipes placed concentrically one within the bore of another, and takes from two to three hours to liquefy air; while the Hampson and Tripler plants, working from a compressor, both have air at two pressures only; both use no preliminary refrigeration, both have simple pipe closely coiled, and both liquefy air in less than fifteen minutes. It would therefore have been more correct, since the Hampson machine is the older of these two, to change the names used by Dr. Sloane, and say that the Tripler apparatus "is very simple, and resembles very much the" Hampson "apparatus, and it works precisely on the same lines."

The salient feature of the book, as a historical summary and appreciation, is the glorification of Mr. Tripler and American invention. The greatness of Mr. Tripler's achievements is compared to his advantage with the paltry efforts of European experimenters in many places, as on pp. 255, 289, 290, 355, and 356; and on p. 296 he is roundly called 'the originator of the self-intensive system." Dr. Sloane's repeated use of the phrase "back of" instead of "behind" suggests that he is probably an American; and if that is so, patriotism might be allowed to excuse the over-laudation of a fellow-countryman in cases of real merit. It cannot, however, justify the ascription of unreal achievements. Mr. Tripler did not show to the public his liquid air made by the self-intensive method till 1897, nearly two years after that method had been published and fully described in Europe; and as he has produced no evidence of having used it privately before, he cannot be accepted as its "originator." Dr. Sloane, it is true, in a summary of Mr. Tripler's work as the inventor of the self-intensive process, says on p. 288 that "about 1891 air was liquefied" by that gentleman. If this be true, both Dr. Hampson and Dr. Linde must give up their claims to priority; but something more than this vague and unsupported statement is necessary to prove that Mr. Tripler had invented the process before November 1894 and May 1895, the earliest authenticated European dates for the invention. It is indeed inconceivable that, if Mr. Tripler had understood the subject well enough to invent and successfully work the process in 1891, he could in 1893 have devised the futile and absurd scheme described in his patent of that year referred to above. Mr. Tripler's later apparatus, too, is insufficiently explained and authenticated if his claims to the invention of it are to be seriously considered. Dr. Sloane must know that the chief interest of this process centres in the arrangements for expansion and interchange of temperatures, and in illustrating the European systems he very properly gives sectional views which clearly explain the nature of these arrangements. But in illustrating Mr. Tripler's machine, while he gives needless views and descriptions of the rooms, the people, and such well-known appliances as three-stage compressors, coolers, and washers, he shows only the outside of the vitally important interchanger. Why did not Dr. Sloane ask for sectional views of this and of the mysterious "special valve, the invention of Mr. Tripler"? We could then have judged how far they really differ from those shown and used in Europe nearly two years before. He informs us in the preface that his requests for assistance in the compilation of his book met with quick response from Mr. Tripler among others. In connection with liquid-air processes there has been too much mystery made, the public being freely asked for their admiration and faith without being frankly made acquainted with the details of an inventor's process and the evidence of his originality. Strangely enough Dr. Sloane, who so complacently accepts Mr. Tripler's mysteries, is himself, on p. 238, an objector to their prevalence in similar work at the Royal Institution. So much attention has lately been excited by Mr. Tripler's scheme for using liquid air as a means of providing unlimited power without cost, that Dr. Sloane might fairly have been expected to give his unscientific readers some useful guidance by explaining how these schemes violate hitherto inviolable laws as to the latent heat of volatilisation of gases, and are, in fact, blunders due to a mistaken interpretation by Mr. Tripler of one of his experiments. Instead of this, Dr. Sloane, on p. 289, gives Mr. Tripler's schemes a mild approval and support by saying that

"the utilisation of the low-grade heat energy of the universe presents nothing essentially impossible. This heat Tripler hopes to utilise. If it is utilised, &c. . . ."

Such toleration of Mr. Tripler's amazing proposals would disqualify any writer as a serious scientific critic.

A MANUAL OF ANTHROPOLOGY.

The History of Mankind. By Prof. Friedrich Ratzel. Translated from the second German edition by A. J. Butler, M.A.; with Introduction by E. B. Tylor, D.C.L., F.R.S. With coloured plates, maps, and illustrations. Three volumes. Pp. xxiv + 486 + 562 + 599. (London: Macmillan and Co., Ltd., 1896.)

THE student of anthropology will welcome this handsome English edition of Prof. Ratzel's "Völkerkunde" as an invaluable work of reference for the numerous and scattered branches of his study. Perhaps no department of science embraces so large a field as the study of man and the history of civilisation, and in proportion to its complexity the greater is the necessity for some general guide to the subject. On the first publication of the work in the years 1885–88 it was at once recognised as the most comprehensive survey of the state of our knowledge of the lower races of mankind that had hitherto appeared, and since that time it has maintained its position in Germany as the standard popular work on the subject. The present English translation has been made from the second German edition, and may therefore be regarded as in all essentials abreast of recent research. In his Introduction, Prof. Tylor has called attention to the large number and accuracy of the illustrations with which the book is furnished, and which he well remarks surpass in excellence any that have yet been issued in similar works intended for general circulation. The importance of good illustrations in contrasting the successive stages of the development of the human race cannot be over-estimated, for they convey far more to the general

reader than long descriptions and strings of technical terms.

In the main the book may be regarded as the best introduction yet available for the beginner who wishes to gain a general knowledge of anthropology and its results as applied to the study of the barbarous and more primitive races of the world. The book is not intended as a guide to the literature of the subject, nor as a work of reference for every specialist in his own department of the science, but is throughout addressed to the general reader. With this aim in view, Prof. Ratzel has disencumbered his pages of all foot notes and references to authorities, and has applied himself to giving, as far as possible, a sketch of results without overloading any portion of his work with the discussion of technical or unnecessary detail. In so doing, the author has been well advised, for not otherwise could his outline have approached completeness within the limits to which it was necessarily restricted.

Prof. Ratzel has treated his subject in five sections or books, the first of which is introductory, while the others roughly correspond to the principal ethnological divisions of the human race. In Book i. he has given a very clear sketch of the principles of ethnography, describing the distribution and general aspects of mankind, the rise of civilisation, and the development of language, religion, science and art, and family and social customs. The next three books describe the more important undeveloped races of the present day. Thus Book ii. deals with the American Pacific group of races, under which heading are included the races of Oceania, the Australians, the Malays and Malagasies, the American tribes, including the ancient civilised races of America, and the Arctic races of the Old World. Book iii. is devoted to the light stocks of South and Central Africa, such as the Bushmen, the Hottentots and dwarf races, while Book iv. deals with the Negro races found throughout Africa. Book v., the last section of the volume, gives a general sketch of the cultured races of the Old World. This brief summary of the contents of the volumes will serve to indicate the very comprehensive character of this history of mankind. The treatment of some of the sections of the book might perhaps have been a little fuller with advantage, but, even in sixteen hundred pages, considerable condensation was obviously necessary; and with so trustworthy a guide as Prof. Ratzel the reader need not fear that any essential facts have been inadvertently overlooked. A special word of praise should be given to Mr. Butler, not only for the excellence of his translation, but also for the care with which he has verified and corrected the descriptions of the numerous illustrations in the text.

OUR BOOK SHELF.

A Theory of Reality. By Prof. George Trumbull Ladd. Pp. xv + 556. (London: Longmans, Green, and Co., 1899.)

PROF. TRUMBULL LADD'S "Theory of Reality," though intelligible in isolation, is a sequel to his "Philosophy of Knowledge" published in 1897, and a link in a chain of development beginning so far back as 1887. The Yale professor makes severe demands upon his public. His voluminous and discursive activity has now produced its fifth harvest, and we take it that there is at least a sixth to come. A certain condensation, therefore, and the taking of some things, *e.g.* the propriety of metaphysics, for granted, would not be out of place. Whatever be the case with the category of time, the reader's time is not unlimited. As compared, however, with its immediate forerunner, the irrelevance and repetition in the present work are only relative. And the review of his intellectual progress, with which the book closes, accounts in a not uninteresting way for his tiresome method of exposition.

Prof. Ladd's theory, which is avowedly speculative, may be described as a Realism of Spirit. It takes its starting-point from self-felt activity, finds "trans-subjective" elements involved in every cognition, and projects upon these by way of analogy the notion that they, too, are real centres of self-activity. "Things are known as imperfect and inferior selves." "The inner reality of all beings is spirit." "The transcendental reality of time is the all-comprehending life of an absolute self." "Viewed in its ontological aspect, all the growth of man's cognitive experience reveals the being of the world as a unity of force, that is constantly distributing itself amongst the different beings of the world so as to bestow on them a temporary *quasi*-independence, while always keeping them in dependent inter-relations, for the realisation of its own immanent ideas." This is not idealism, though in its affirmation of spiritual unity it steals the idealist's thunder. The nature of our knowledge of self and of the dynamical character of its agency necessitates realism; though, on the other hand, because connection according to some law must be predicable of reality, we are able, in the most satisfactory chapter of the book, to consider reality as an actual harmony of categories.

The interdependence, and neither independence nor dependence, of the categories is admirably treated, and Prof. Ladd discusses each in turn. He has in general (Pref., p. ix.) submitted the chapters which come into closest relations with the physical sciences to expert friends and colleagues. The treatment, however, of matter and ether as separate kinds of entity, though it may follow from his scientific definition of matter, presents difficulty to the metaphysical reader. Is ether then immaterial? The explanations of pp. 447–448 only partially solve the knot. Nor is it possible to agree with the symbolisation of time as a continuous flow of n infinites, and of space as in each moment an infinite content which equals and is known to equal n terms (p. 250). Prof. Ladd's point is, of course, to express the infinite simultaneous, but his symbols are misapplied.

H. W. B.

Great and Small Game of Africa; an Account of the Distribution, Habits, and Natural History of the Sporting Mammals, with Personal Hunting Experiences. Edited by H. A. Bryden. Pp. xx + 612; illustrated. (London: Rowland Ward, Ltd., 1899.)

THIS magnificent volume is a unique work on the subject of which it treats; the greater part of the text being written by well-known African sportsmen (among whom Mr. F. C. Selous occupies a prominent position), while a naturalist is responsible for the classification, nomenclature, and the leading distinctive features of the main groups. It is thus written throughout as the result of actual experience, and accordingly possesses a value far above the ordinary type of natural histories. Although mainly written for sportsmen, the professional zoologist cannot fail to find much matter bearing upon his own studies; and the African sportsman should no longer have any difficulty in identifying any of the species (unless they be new) which may fall to his rifle. The coloured illustrations, which for the most part are restricted to figures of the heads of the various species, are all that can be desired, both from an artistic and a zoo-

logical point of view. The book is invaluable to all interested in the natural history of Africa, and is especially important as indicating the number of game animals to be met with in British territories and dependencies.

R. L.

An Introduction to the Carbon Compounds. By R. H. Adie, M.A., B.Sc. Pp. viii + 90. (London: W. B. Clive.)

WITHIN the brief compass of this work the author aims at introducing the student to some of the chief groups of the carbon compounds, as represented by familiar substances, and at the same time at providing a series of experiments to illustrate the properties and reactions of these compounds. Thus the subject of the hydrocarbons is developed from an examination of the properties of coal gas, which leads to the study of marsh gas, ethane, olefine, acetylene and benzene. A feature of the book is that aromatic compounds are described along with fatty derivatives belonging to the same group, phenol along with alcohol, benzoic and salicylic acids along with acetic acid, aniline along with ethylamine, &c. This arrangement of the matter produces, no doubt owing to the severe compression, a somewhat disconnected effect, as it in many cases prevents a complete and logical discussion of the constitution of the compounds which are mentioned. This renders the book less suitable for absolute beginners than for students who have already a slight elementary acquaintance with the subject, and to these it cannot fail to afford valuable assistance. The experiments are on the whole well selected, but they are conducted on purely qualitative lines, no attention being paid to that important factor—the yield. A. H.

LETTER TO THE EDITOR.

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On the Deduction of Increase-Rates from Physical and other Tables.

PROF. PERRY has called my attention to a want which sometimes arises in making practical deductions from tables. Take the following example.

θ° C.	p	Δp	$\Delta^2 p$	$\Delta^3 p$
90	1463			
		302		
95	1765		49	
		351	**57**	**8**
100	2116	**408**	62	5
		470	**70**	**8**
105	2524	540	78	
		618		
110	2994			
115	3534			
120	4152			

The table gives in the second column the pressure of steam for the temperatures stated in the first column, which proceed by equal steps of 5°. The question is, how best to derive from these data the value of $\frac{dp}{d\theta}$ at one of the stated temperatures, say 105°.

The column Δp gives the differences between consecutive values of p. The column $\Delta^2 p$ gives the differences between consecutive values of Δp, and so on. The third differences $\Delta^3 p$ exhibit so much irregularity that it is not worth while to proceed to fourth differences.

It is obvious that the required result is greater than $\frac{1}{5}$ of 408, and less than $\frac{1}{5}$ of 470. Half the sum of these two is a fair first approximation. Closer approximations can be obtained by means of the numbers printed in large type. Let the downward sloping series 470, 70, 8 be called d_1 d_2 d_3, and the upward sloping series 408, 57, 8 be called u_1 u_2 u_3. Also let the common difference 5° be denoted by h.

It is known to mathematicians that $h\frac{dp}{d\theta}$ is theoretically equal to $d_1 - \frac{1}{2}d_2 + \frac{1}{3}d_3 - \&c.$, and also to $u_1 + \frac{1}{2}u_2 + \frac{1}{3}u_3 + \&c.$, both series being supposed to be continued till we reach an order of differences that vanishes.

In physical tables, usually no column of differences vanishes exactly, and the two series will not exactly agree. The question is, how to get the best practical approximation out of them. The most obvious plan is to add them, and write

$$2h\frac{dp}{d\theta} = (d_1 + u_1) - \tfrac{1}{2}(d_2 - u_2) + \tfrac{1}{3}(d_3 + u_3) - \&c.,$$

then to take the first bracketed expression, the first two, the first three, &c., as first, second, third, &c., approximations. But it will be found on trial, in the present instance and in most instances, that the second approximation so obtained is less exact than the first.

I find, on looking into the matter strictly, that the proper second approximation is

$$2h\frac{dp}{d\theta} = (d_1 + u_1) - \tfrac{1}{6}(d_2 - u_2).$$

This equation would be exact if p were capable of being expressed in the form

$$p = A\theta + B\theta^2 + C\theta^3 + D\theta^4.$$

As applied to the example before us, it gives 87·7 as the value of $2h\frac{dp}{d\theta}$, and 8·77 as the value of $\frac{dp}{d\theta}$. This is as close an approximation as is warranted by the data. The first approximation $(d_1 + u_1)$ is 87·6.

The two series $d_1 - \frac{1}{2}d_2 + \&c.$, and $u_1 + \frac{1}{2}u_2 + \&c.$, carried each to three terms, give respectively 87·53 and 87·83.

The proper third approximation, which would be exact for

$$p = A\theta + B\theta^2 + C\theta^3 + D\theta^4 + E\theta^5 + F\theta^6,$$

is

$$2h\frac{dp}{d\theta} = (d_1 + u_1) - \tfrac{1}{6}(d_2 - u_2) + \tfrac{1}{30}(d_3 + e_3).$$

Another requisite is to determine $\frac{d^2p}{d\theta^2}$. When the fourth order of differences vanishes, I find that $d_1 - u_1$ is the accurate value of $h^2\frac{d^2p}{d\theta^2}$. In the present instance this gives

$$\frac{d^2p}{d\theta^2} = \frac{62}{25} = 2{\cdot}48.$$

The formulæ most employed hitherto for this purpose are

$$h^2\frac{d^2p}{d\theta^2} = d_2 - d_3 + \frac{11}{12}d_4 - \&c.$$

$$= u_2 + u_3 + \frac{11}{12}u_4 + \&c.$$

which, if we include two terms of each, give respectively $\frac{62}{25}$ and $\frac{65}{25}$.

When fourth and fifth differences are worthy of attention, the correction to be made for them consists in adding

$$\tfrac{1}{30}(d_1 - u_1) - \tfrac{1}{12}(d_2 + u_2)$$

to the first approximation $d_1 - u_1$.

To take account of fifth and sixth differences, this correction must be supplemented by a further addition of

$$\tfrac{1}{75}(d_1 - u_1) - \tfrac{3}{80}(d_2 + u_2) + \tfrac{3}{80}(d_3 - u_3).$$

Without occupying space by a detailed investigation, I may say that my plan of procedure is first to write down (by Taylor's theorem) the expansions for the first differences in ascending powers of h; then so to combine them in pairs by subtraction as to eliminate all even powers; then to eliminate h^3 from two of the resulting equations. This gives.

$$2h\frac{dp}{d\theta} = (d_1 + u_1) - \tfrac{1}{6}(d_2 - u_2)$$

when h^5 is neglected.

The next approximation is obtained by eliminating both h^3 and h^5 from three of the equations.

In the first operation for deducing $\frac{d^2p}{d\theta^2}$ the pairs are combined by addition instead of subtraction, thus eliminating all odd powers of h.

This gives $d_1 - u_1 = h^2\frac{d^2p}{d\theta^2}$ when h^4 is negligible. The succeeding approximations are obtained by eliminating first h^4 and then both h^4 and h^6.

J. D. EVERETT.

THE PENYCUIK EXPERIMENTS.[1]

THE well-devised breeding experiments now in progress at Penycuik under the direction of Prof. J. Cossar Ewart, are, it need scarcely be said, of the highest interest both theoretical and practical. To the general biologist the subject of hybridisation affords a wide field for the investigation of laws of heredity, and especially of such subsidiary factors, whether real or only imaginary, as reversion, prepotency, saturation and telegony; while the question of the sterility of hybrids has important bearings on the general theory of evolution. But besides the purely scientific aspects of the problems which are now being attacked by Prof. Ewart, there is also their practical application, which appeals with much force to the interests of the breeder of stock. It is of course true that the whole history of animals and plants under domestication may be said to provide a body of experiments in these and similar subjects on a very large scale; and it is undoubtedly the case that many of the questions referred to have been already answered, at least provisionally. The experience of many generations of breeders has led to the emergence of certain practical rules, which are seldom if ever disregarded by those whose interests are concerned in the rearing of animals with a definite object. But it still remains doubtful how far the widely-accepted doctrines of fanciers and other breeders rest upon any firm scientific basis; and it is certainly most desirable that precise experiments should be undertaken with the sole object of arriving at the truth in such matters as prepotency, telegony and the effects of inbreeding. It cannot but be to the advantage of breeders if empiric methods founded on vague conjecture and imperfect generalisation can be made to give place to a rational system derived from exact knowledge of facts. Prof. Ewart's design ought therefore to meet with a warm welcome in scientific and practical quarters alike.

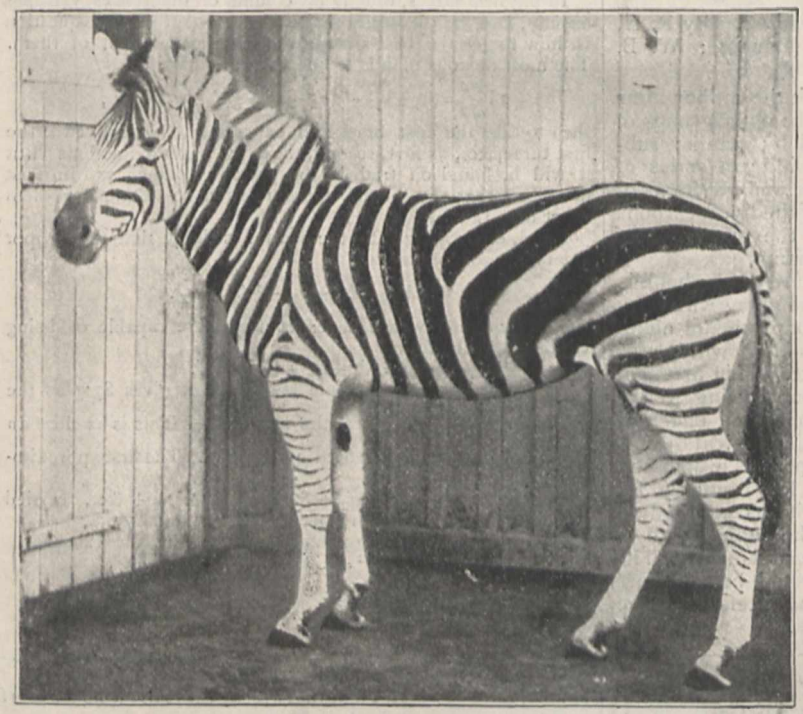

FIG. 1.—Matopo.

The volume before us contains an account of such results of the author's experiments as are now sufficiently mature for publication. It is not so much a book as a re-issue in book form of three papers that have already seen the light, together with a general introduction which, to some extent, summarises and supplements the information subsequently given. Prof. Ewart remarks that "as the problems under consideration are not of a kind that can be settled off-hand, and as one inquiry has begotten others, some years must elapse before a complete and systematic account is possible." Meantime, he thinks, the publication of his results in their present form "will indicate the lines along which the inquiries are proceeding, and also the kind of answers likely eventually to be made to some of the questions." Regarded in this way as an instalment, the volume well fulfils its purpose.

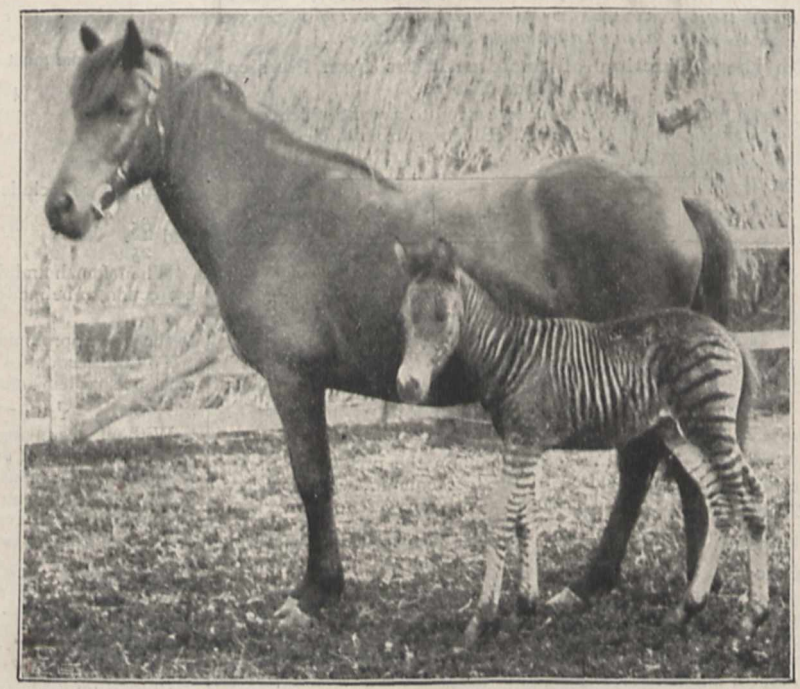

FIG. 2.—Romulus (seven days old) and his dam, Mulatto.

The first paper is chiefly devoted to a detailed descrip-

[1] "The Penycuik Experiments." By J. C. Ewart, M.D., F.R.S., Regius Professor of Natural History, University of Edinburgh. Pp. xciii + 177. (London: Adam and Charles Black, 1899.)

tion of "Romulus," a hybrid colt whose sire "Matopo" is a Burchell's zebra of the *Chapmani* form, and whose dam "Mulatto" is an Island of Rum pony. "Mulatto" was afterwards crossed with a grey Arab stallion "Benazrek," and a description of her second foal, which unfortunately only lived for a little over five months, is given in the last paper under the head of "Telegony and Reversion." The foal in question was naturally a centre of great interest, inasmuch as from its parental history it afforded an opportunity for the operation of the alleged principle of telegony. The answer returned by nature to this particular interrogation was, as is so often the case, ambiguous. The colt was certainly striped, but the stripes were not like those of Mulatto's first mate; nor, on the other hand, did they entirely resemble those stripes often obscurely visible in ordinary foals. The evidence so far, though in no way conclusive, seemed to be capable of interpretation in accordance

FIG. 3.—Matopo.

with the theory of telegony. However, in the general introduction, after giving the results of a fresh comparison with pure-bred foals, and adding an account of three additional experiments of the same kind, the author concludes that in no one of these cases is it possible to maintain that infection, saturation, or telegony has taken place. The results of further trials with rabbits, dogs and pigeons have also at present been uniformly negative.

In the second paper, particulars are given of a further batch of hybrids sired by the same zebra stallion "Matopo"; the dams being respectively a Shetland and an Iceland pony, an Irish mare and a cross-bred Clydesdale mare. All presented points of interest, and the extent to which they resembled their sire or respective dams varied much, but it was found that even those which in several characters most distinctly suggested the zebra sire differed entirely from him in markings. According to Prof. Ewart, the markings of his hybrids accord fairly with those of the Somali zebra, which he regards as being the most ancestral in its colour-pattern of all recent Equidæ.

If this is really the case—and it is difficult to find any weak spot in the author's cautious yet cogent line of argument—the hybrids in question supply one more good illustration of Darwin's principle that the crossing of distinct species frequently leads to reversion. It may here be remarked that precisely the same conclusion seems to follow from the elaborate experiments in the hybridisation of insects recently conducted at Zürich by Dr. M. Standfuss. The latter investigator, it is true, speaks only of the "prepotency of the phylogenetically older" of the two parent species; but, while he refrains from actually using the term "reversion" with regard to his hybrids, he records the fact that some of them exhibit characters which must have belonged to an

FIG. 4.—Romulus.

ancestor of one of the parent species, though absent from the parents themselves.

With regard to the zebra hybrids now under discussion, the most striking point of difference in marking between "Romulus" and the other cross-bred foals on the one hand, and their common sire "Matopo" on the other, is the multiplication of stripes in the former, and the tendency to the production of a gridiron pattern over the rump. The last-named of these characters resembles the condition seen in the mountain zebra, an earlier form, according to Prof. Ewart, than the Burchell group, while the former point recalls the still more ancestral pattern of the Somali zebra. In the Shetland pony's hybrid, "Norette," the pattern over the hind-quarters from the first resembled that of the Somali zebra; in the other hybrids, the markings of the same region, indeterminate at first, finally settled down into a form suggestive rather of the less remote stage marked

by the mountain zebra. The difference in the general system of striping between "Matopo" and his offspring is well brought out in the figures here reproduced, by the courtesy of the publishers, from Prof. Ewart's work. A more special point, but one of great interest, is that exemplified in the accompanying figures of the brow-stripes in "Matopo," in "Romulus," and in a Somali zebra. The numerous rounded arches shown on the forehead of "Romulus" are very different from the four or five acutely pointed arches of "Matopo," and clearly bear a much greater resemblance to the corresponding pattern of the Somali zebra. It should, however, be mentioned that a system of brow-striping not unlike that of "Romulus" occurs in Crawshay's zebra, a member of the Burchell group.

On one point of special importance the experiments have so far given results that, however interesting

FIG. 5.—Somali Zebra.

scientifically, are from the practical side disappointing. Following a suggestion of Captain Lugard, that zebra mules might possibly turn out to be immune to the disease communicated by the tsetse fly, and might thus help in solving some of the difficulties of African transport, Prof. Ewart, with great liberality, inoculated three of his hybrids with some of the tsetse organism at that time under investigation by Messrs. Blandford and Durham. The result of this experiment is not given in the present volume, but in the recently published *Proceedings* of the International Congress of Zoology at Cambridge it is stated that the inoculated animals, though apparently somewhat more resistant than horses, all died in about eight weeks.

The above-mentioned are a few only of the points of interest brought out by the remarkable series of experiments dealt with in the present volume, but enough has probably been said to show the importance of the problems which Prof. Ewart has set himself to solve, and the prospects of advance in knowledge which these researches hold out. It only remains to say a word in commendation of the general get-up of the book, and of the character and accuracy of the illustrations, which in many cases are reproduced from actual photographs. The absence of an index or detailed table of contents is a drawback, but this, like the frequent repetition of the same facts, is perhaps inseparable from the method of publication adopted. A tabular list of the hybrids, giving their parentage and the more important features of their aspect, might be a useful addition, as the reader finds it a little difficult at present to piece together the various details, scattered through many parts of the work, under their proper headings. But any small defects of this kind will, no doubt, be completely remedied in the connected and systematic account of the fruit of his researches which Prof. Ewart leads us to hope for at some future time. Meanwhile, the course of his experiments will be watched with keen interest by all those who realise the importance, both scientific and practical, of a right conception of the laws of heredity. F. A. D.

PIONEER CLIMBERS.[1]

NOTWITHSTANDING what has been done by Coolidge and Freshfield, by C. E. Mathews and F. Pollock, for the pioneers in mountain climbing, there is still room for a book so comprehensive as that before us. Mr. Gribble has collected a quantity of interesting information, and prints at the end of his work several rare and curious documents. It is, moreover, not wholly restricted to the Alps, for it touches on early ascents in the Pyrenees and the Apennines. These, however, are distinctly subordinate; the interest, as is only natural, centres on the mountain backbone of Europe. This is many-sided, but on the present occasion we must restrict ourselves to aspects more or less scientific. A wide question is suggested at the outset: What caused that horror of mountains which was evidently so genuine among the chief nations of Europe till a period comparatively late in history? It was not felt by the Hebrew, as Mr. Gribble shows, but the Greek seems to have cared little for them, and the Roman detested them. Perhaps the practical nature of this people viewed them as an impediment to "imperial expansion," a sentiment hinted at in Napoleon's question, "When will the Simplon be practicable for cannon?" Moreover, in Rome's more luxurious days the rough roads, hard fare, and bad lodging of a journey across the Alps would naturally be objectionable. Classical influences, with a certain sympathetic similarity, may have caused the dislike once so general among our own countrymen, which has only been changed during the last thirty or forty years. These have witnessed a revulsion of sentiment which, whatever be its cause, is certainly one of the remarkable features in the later part of the nineteenth century.

But to pass from a general question to more particular topics, we can incidentally gather from this volume no bad idea of how some parts of scientific knowledge have advanced during the last four centuries. Prior to this epoch men knew little of science, and less of the mountains; pioneers were few, and the history of climbing—except when there was no help for it—was almost

[1] "The Early Mountaineers." By Francis Gribble. Illustrated. (London: T. Fisher Unwin, 1899.)

a blank. A monk of Canterbury, who crossed the Great St. Bernard late in the twelfth century, piously prayed that none of his brethren might come into that place of torment, and till long after that, though Leonardo da Vinci set a better example, and pilgrimages even began

FIG. 1.—John Tinner's Dragon.

to be made to the top of the Roche Melon, the Alps found few to praise them. Fancy invested them with superstitious terrors, of which the legend of Pilatus is an apt example, but here and there we come on the track of a sceptical traveller. In the first rank of these forerunners of the modern man of science is Conrad Gesner, who laughed at those stories, and was a true lover of the mountains. His successor, Josias Simler, even describes, about the year 1574, the precautions to be taken in crossing snowfields and glaciers, but the seventeenth century had begun before any careful note was taken of the latter. Then the fact of their motion was observed, and was communicated some years later, in 1669, to our own Royal Society; but the first speculations as to its cause appear to have been published by J. J. Scheuchzer, a professor, like the two first-named, at Zürich. Though evidently ill-adapted for mountain walking, he stuck bravely to it for some years at the beginning of the eighteenth century, and at last published two bulky volumes with numerous illustrations. These, in many respects, are interesting as a picture of Switzerland long before the coming of the tourist. But his book testifies to other changes, for it is full of dragon stories, and gives us portraits (such as that now printed) of many a loathly worm which now finds no representative on land, whatever it may do in the sea. Scheuchzer, in fact, though a good mathematician and a keen observer of minerals, plants, and even glaciers, had no critical faculty. He represents a type of student not yet extinct—the man whose first care is for "the literature of the subject," and who attaches an equal value to everything which appears in print. But before long in De Luc and Bourrit, and lastly in the really great De Saussure, scientific mountain travel begins, and the new era may be said to dawn. Now science finds in the Alps a workshop as well as a playground, and special memoirs such as that on Mont Blanc, noticed in these columns on June 15 (p. 152), are becoming common. Yet it is only just over a century since the last volume of "Voyages dans les Alpes" appeared.

Many curious illustrations, as we have intimated, are reproduced by Mr. Gribble, some indicating the strides which have been made in the representation of scenery, especially Alpine, during the last two centuries. The one given below was published about the year 1760, yet it bears little resemblance to nature, while some earlier than it are still more completely conventional. Incidentally the quotations in this volume throw light on the fauna of the Alps, showing, for instance, that bouquetin were common in districts from which they have long vanished. Indeed, odds and ends of curious lore abound in these pages; so that we have to thank Mr. Gribble, not only for an amusing book, but also for a valuable addition to Alpine literature.

T. G. BONNEY.

BOWER-BIRDS.

SINCE the year 1840, when Gould communicated to the Zoological Society an account of their extraordinary "runs," as they are locally called, the Bower-Birds of Australia and Papua have always attracted a large share of interest on the part not only of ornithologists but of students of the habits of animals. For in the construction of the "bowers" or "runs," from which they take their name, these birds stand absolutely alone, although the "playgrounds" of the Argus pheasant are comparable to the smooth patches cleared in the jungle by one species of Bower-Bird. On such an interesting subject it is of the utmost importance to have as much definite information as possible at first hand, and we are therefore glad to welcome the paper on the Australian representatives of the group, from the pen of an original observer—Mr. A. J. Campbell, of Melbourne—which appears in the last issue of the *Proceedings* of the Royal Physical Society of Edinburgh, special value attaching to this communication from the excellent photographs of "runs" and nests with which it is illustrated.

FIG. 2.—Grüner's view of the Lower Grundelwald Glacier.

As there may be a lingering idea that the "runs" of these birds have some connection with nesting, it may be well to state that this is altogether a mistake. The nests, of which beautiful examples are figured by Mr. Campbell, present indeed no special features, being built at a height of from ten to fifteen feet above the ground, and usually containing at the proper season two, or sometimes three, eggs. These latter, however, cannot fail to attract the collector by their porcelain-like polish and beautifully pencilled markings. Thanks to the energy of Australian ornithologists, the nests and eggs of most of the species are now known, although some are rare and difficult to find.

"Run" of Great Bower-Bird. From a photograph taken in Western Australia by Mr. H. H. Johnston. (From the *Proceedings* of the Royal Physical Society of Edinburgh.)

Among the more elaborate types of "runs" or "bowers," the author figures those of the Satin Bower-Bird, the Spotted Bower-Bird, the Great Bower-Bird, the Queensland Bower-Bird, and the Regent Bird; the third of these being herewith reproduced. The photographs confirm previous statements as to the two types of decoration employed in these bowers, the taste of the Satin Bower-Bird displaying itself in the selection of bright-coloured parrot-feathers, while the other species named prefer bones and shells. The Spotted Bower-Bird may be described as a collector of sheep's bones (especially the vertebræ), whereas the Great Bower-Bird accumulates bleached shells. As is the case with the "Viscacherias" of the Argentine Pampas, in a Bower-Bird haunted country it is well to search the "runs" for any glittering objects, such as money or jewellery, which may have been lost in the neighbourhood. The amount of grass and sticks employed in some of these "bowers" is enormous, one structure being described as ranging from four to six feet in height.

In one respect Mr. Campbell does not agree with some writers, who have stated that the Cat-Birds (*Aeluroedus*) differ from other members of the group in that they build no bower, but content themselves with clearing a space of ground. No such spaces have, however, according to our author, yet been observed; and it is suggested that the birds may merely play on some fallen log. On the other hand, the Tooth-billed Cat-Bird (*Scoenopaeus*) of North Queensland does undoubtedly clear such spaces, upon which are laid at intervals a few leaves of one particular kind of tree. This represents the simplest type of "run," the most complex being that of the Gardener-Bird (*Amblyornis*) of New Guinea, which builds an orchid-covered hut, with a mossy lawn in front, ornamented with brilliant flowers and berries.

As to the object of these strange structures, Mr. Campbell has no new suggestion to offer, and we may therefore conclude that he accepts the old "playground theory." R. L.

THE COSMIC ORIGIN OF MOLDAVITE.

MUCH attention has recently been devoted by Austrian and Bohemian geologists to the solution of an interesting question, that of the origin of those peculiar glassy bodies which are known collectively as moldavite or bouteillenstein. It has been considered by some authors that these fragments are to be looked upon as representing the relics of prehistoric glass-manufacture; but, as recently noted in the columns of NATURE, Herr J. Bareš has lately brought forward experimental proofs to refute the theory of the artificial origin of moldavite glass. Additional stimulus has been given to the study of this problem by the recent enunciation of a

new theory. Dr. F. E. Suess has expressed the opinion that these glassy fragments bear strong analogy to meteorites, and that they are in reality, like the latter, aerolites. In support of this view, in addition to other arguments, he lays special stress on the nature of the peculiar, though varying, surface sculpture of bouteillenstein, a sculpture not consistent with any theory of mechanical transport in water. Prof. Rzehak, however, has opposed this hypothesis of a cosmic origin, and brings forward arguments for its refutation. This author rather inclines towards the theory of an artificial origin; but Bareš, by experiments above referred to, applied a process of elimination to the various theories put forward for the terrestrial origin of the glass, and finally considered that of Dr. Suess to be most probably the correct one. A recent contribution to the literature of this subject is a short paper brought before the Böhmische Kaiser Franz-Josefs Akademie (Prague) by J. N. Woldrich last December. An abstract of this appears in the *Bulletin International* (dated 1898) issued by the Academy, and from the photographs illustrating that paper the accompanying figures have been selected for reproduction.

FIG. 4.

FIG. 8*a*.

FIG. 6.

Herr Woldřich describes the surface markings of specimens in his own large collection, and points out the resemblance between certain of these Bohemian examples and the peculiar obsidian-bombs from Australia, described by Stelzner. Some of the Bohemian occurrences show, n fact, a hollow, bomb-like form. A fragment of such a specimen is represented in Fig. 8*a*. Figs. 4 and 6, photographed in natural size, show two characteristic types of sculpture, Fig. 4 exhibiting "finger impressions," and Fig. 6 a network of furrows, having in part a rough radial arrangement. The moldavite found both in northern and southern Bohemia occurs in sandy deposits which are regarded as belonging to either late Tertiary or early Diluvial time. Herr Woldřich considers that the known facts relating to moldavite and its distribution speak in favour of its extra-terrestrial origin, but that it is only known to occur in sandy deposits, whether in Europe or on other parts of the earth's surface, he regards as a striking circumstance.

NOTES.

AT a meeting of the Glasgow University Court held on the 13th inst., Principal Story presiding, a petition for leave to retire from the chair of Natural Philosophy was presented from Lord Kelvin. The Court granted the leave asked, and accepted Lord Kelvin's resignation with deep regret. A remit was made to the Principal to prepare a minute to be signed by all the members of the Court, expressing their sense of the great loss that the University is now to sustain. Lord Kelvin has occupied the chair for fifty-three years.

DR. P. F. RAYMOND, the successor of Prof. Charcot in the chair of Nervous Diseases at the Saltpêtrière, has been elected a member of the Paris Academy of Medicine.

PROF. KLEIN proposes to spend two or three weeks in this country, so that, after the work of the Catalogue Conference is finished, he can have an opportunity of discussing, with our mathematicians and physicists, the plan and scope of the second part of the *Encyklopädie der Mathematischen Wissenschaften*, which deals with Applied Mathematics. The season for his visit is in some respects unfortunate, as being a holiday time; on the other hand, there is the advantage that those who are to be found at home will have plenty of leisure to devote to the discussion of the details of this great work.

THE death is announced, at the age of eighty-seven years, of the Right Rev. Charles Graves, Lord Bishop of Limerick, who in 1843 was appointed Erasmus Smith professor of pure mathematics at Trinity College, Dublin. His published work appeared for the most part in *Crelle's Mathematical Journal*, and many of his theorems are to be found in text-books on geometry. In 1841 he edited a translation, with considerable additions, of Chasles' "Memoirs on Cones and Spherical Conics." He was elected President of the Royal Irish Academy in 1861, and a Fellow of the Royal Society in 1880.

THE death is announced in the *Athenaeum* of Dr. Eugen Ritter von Lommel, Rector of the University and a member of the Academy of Sciences of Munich. He was the author of several works, including "Das Wesen des Lichts," "Wind und Wetter," and "Lexikon der Physik und Meteorologie."

THE negotiations which for some time past have been carried on between the Royal Geographical Society and the University of Oxford with a view to the establishment at Oxford of a fully-equipped school or institute of geography, for the use, not only of Oxford graduates and undergraduates, but of others who desire to avail themselves of such an opportunity, have come to a satisfactory conclusion, and the school will begin operations in October next, under the direction of Mr. H. J. Mackinder. The Royal Geographical Society is to contribute 400*l.* annually for five years out of the 800*l.* required, and the school will be under the supervision of a joint committee of representatives of the Society and the University. At a recent meeting of the committee, the staff was appointed, Mr. Mackinder being the head of the school, and dealing specially with historical geography; Mr. A. J. Herbertson has been appointed assistant to the Reader, and will deal with physical geography, cartography, and surveying; Mr. H. N. Dickson has been appointed Lecturer on Physical Geography; and Mr. G. B. Grundy will in 1899–1900 lecture on ancient geography. The work of the school will include a course of systematic instruction primarily intended for graduates and other advanced students, with classes, demonstrations, and practical work in physical geography, cartography, and surveying. Courses of lectures will also be given with special reference to the historical and scientific teaching of the University. The work will be carried on for five days each week during term. The lecture-room and laboratory will be in the Old Ashmolean

Museum, the upper floor of which is being fitted with the necessary appliances.

PARTICULARS have reached us of the autumn meeting of the Iron and Steel Institute, which, as has already been announced in NATURE, is to be held in Manchester from August 15 to 18 next. The following papers have been promised for reading:—On the constitution of steel, by Prof. E. D. Campbell; on diffusion in steel, by F. W. Harbord and Thomas Twynam; on the magnetic concentration of iron ore, by H. C. McNeill; on India as a centre for steel manufacture, by Major R. H. Mahon, R.A.; on pig iron fractures and their value in foundry practice, by J. W. Miller; on practical microscopic analysis for use in the steel industries, by C. H. Ridsdale; on the relation between the structure of steel and its thermal and mechanical treatment, by Albert Sauveur; on the present position of the solution theory of carburised iron, by Dr. A. Stansfield; on the iron industry in the territory of his Highness the Nizam, by Shamsul Ulama Syed Ali Bilgrami; on a new casting machine for blast furnaces, by R. Hanbury Wainford; on the utilisation of powdered iron ore, by Prof. J. Wiborgh. In the outline programme, just issued, full particulars are given of a number of excursions for which arrangements have been made.

THE summer meeting of the Institution of Naval Architects, which is taking place this week at Newcastle-upon-Tyne, was opened on Tuesday, when papers were read by Sir Andrew Noble (on "The Rise and Progress of Rifled Naval Artillery"), Dr. F. Elgar (on "The Distribution of Pressure over the Bottom of a Ship in Dock, and over the Dock Blocks"), and Mr. Nelson Foley (on "A New System of Forced Draught").

A CONFERENCE was held at the Home Office on Tuesday with some of the principal pottery manufacturers, in reference to the report by Prof. T. E. Thorpe and Dr. T. Oliver on the employment of compounds of lead in the manufacture of pottery.

Science states that a laboratory for the physical analysis of soils has been established by the Maryland Geological Survey. A full outfit of apparatus has been installed, and work will be engaged in during the coming year upon the soils of Maryland, in conjunction with the geological surveying of the same area. The Survey has also recently had constructed an elaborate calorimeter for the determination of the calorific power of coal, preparatory to the investigations of the coal formations of Maryland, an exhaustive report on which is promised for an early date.

THE Magnetic Observatory at Vienna having had to be discontinued in consequence of the electric tramways and electric light wires, Prof. Pernter has submitted to the Austrian Government a plan for a new observatory to be situated at some distance from Vienna, and to be provided with instruments of the latest construction.

ACCORDING to the *Pharmaceutical Journal*, a committee has been formed in France to organise a public subscription in aid of scientific research, with a view to the discovery of new methods of treatment for infectious and contagious diseases. That the need is pressing will be seen when it is stated that France loses every year by these diseases two hundred and forty thousand victims, nearly double the number of lives lost in the Franco-Prussian war of 1870. Out of this total, tuberculosis is responsible for 100,000 deaths; typhoid fever and other contagious diseases, such as small-pox, measles, scarlatina, whooping-cough, diphtheria, and puerperal fever for 64,000, without speaking of the ravages caused at long intervals by cholera and plague.

THE committee appointed to inquire into the use of preservatives and colouring matters in food held their first meeting on Monday, when there were present Sir Herbert Maxwell, M.P. (in the chair), Dr. Timbrell Bulstrode, Dr. Tunnicliffe, and Mr. C. J. Huddart (secretary). The terms of reference to the committee were under discussion, and certain preliminary matters were disposed of, a second meeting being fixed for early in August to complete arrangements for the carrying out during the hot weather of necessary experiments in relation to the use of preservatives and colouring matters in one and another class of food, and to settle the scope of the evidence to be taken when the committee reassemble in October next.

THE Liverpool expedition for the study of malaria in Sierra Leone, to which attention has already been called in these columns, will sail on July 29. In addition to Major Ross and Dr. Annett, each of the Liverpool School of Tropical Diseases, the expedition will include Mr. E. E. Austen, of the British Museum (Natural History), and Dr. S. Van Neck, official delegate of the Belgian Government. The School of Tropical Diseases has recently been in communication with the various Government departments concerned with regard to the forthcoming research. On July 1 the Colonial Office wrote that Mr. Chamberlain had learned with great satisfaction that the expedition of the Liverpool School was being sent, and that he appreciated the energy and public spirit shown by the Committee of the School in the matter. Mr. Chamberlain also stated that the local authorities at Sierra Leone will be instructed to give every facility to the work of the expedition.

THE Vienna correspondent of the *Times*, telegraphing to that paper on July 14, says the renewed experiments by Prof. Tuma and a number of officers of the Vienna garrison to test the possibility of wireless telegraphy between two balloons were attended with a certain degree of success. A balloon held captive at a height of 150 metres served in place of the mast used in the Marconi experiments, being connected with the despatching instruments on the ground by a copper wire. The second free balloon carried a receiving instrument and a wire which hung loose 20 metres below the car. In these conditions it was found possible to communicate with the three officers in the free balloon, who signalled with flags that they had received and understood the telegraphic messages. These signals were observed at an estimated height of 1600 metres and a distance of about 10 kilometres from the despatching station. Owing to the size and weight of the accumulators and the great danger of bringing them into close proximity to a large volume of explosive gas, it is thus far impossible to telegraph from a balloon to the ground or from one balloon to another. On the return of the officers to Vienna a comparison will be made between the detailed particulars noted by them and the report of the actual messages despatched.

THE Liverpool Section of the Society of Chemical Industry proposes, with the approval of the Council, to perpetuate the memory of the late Dr. Ferdinand Hurter, especially his great services to applied chemistry, by instituting a memorial lecture to be given every second year on some subject connected with applied chemistry. The lecturer will be chosen by the Liverpool Section of the Society, and it is proposed to collect a sum of 300*l.*, which it is supposed will be sufficient for the endowment.

ON the afternoon of Saturday, July 8, a marble bust of the late Prof. William Rutherford, F.R.S., was unveiled in the Physiology Class-room of the University of Edinburgh by Principal Sir William Muir, in the presence of, among others, Sir William Turner, Prof. T. R. Fraser, Prof. Crum Brown, Prof. Hunter Stewart, Dr. Clouston, and Dr. E. W. W. Carlier. The Lord Provost of Edinburgh and Prof. Schäfer sent apologies for absence. The bust, which is by Mr. John Hutchinson, was

subscribed for by past and present members of the class of physiology. It bears the following inscription on the pedestal:—"In piam memoriam Gulielmi Rutherford, M.D., F.R.S., in Universitate Academica Edinburgensi, ab anno MDCCCLXXIV. ad annum MDCCCXCIX., Physiologiæ Professoris hanc effigiem posuerunt discipuli eius Universitatis huius cives. A.D. MDCCCXCIX."

SIR JOHN WOLFE BARRY, K.C.B., F.R.S., has been elected by the Council of the Society of Arts chairman for the ensuing year.

THE fourth International Congress of Psychology will be held in Paris from August 20-25, 1900. The organisation is left to the French members, and the following are the officers: President, Th. Ribot, professor of experimental and comparative psychology in the Collège de France; Vice-President, Charles Richet, professor of physiology in the Paris Faculty of Medicine; General Secretary, Pierre Janet, Director of the Laboratory of Psychology in the Collège de France. The seven Sections and the Presidents are as follows: (1) Psychology in its relations to physiology and anatomy, Prof. Matthias Duval; (2) Introspective psychology and its relations to philosophy, Prof. G. Séailles; (3) Experimental psychology and psycho-physics, M. A. Binet; (4) Pathological psychology and psychiatrie, Dr. Magnan; (5) Psychology of hypnotism and related questions, Dr. Bernheim; (6) Social and criminal psychology, M. Tarde; (7) Comparative psychology and anthropology, Prof. Yves Delage. Those wishing to attend the congress should apply to the Secretary, and those wishing to present papers should forward abstracts not later than January 1 next.

A COMBINED meeting of the German and Viennese Anthropological Societies is to be held at Lindau from September 4 to 7 of the present year.

AN expedition to determine the geological and mineralogical features of the almost unknown region lying between Buffalo Hump, in Idaho County, Idaho, and the Nez Perce Pass, in the Bitter Root range, has been organised and equipped by Colonel W. S. Brackett, of Peoria, Ill. The party numbers twelve men, all of whom are stated to be experienced mountaineers.

REPORTS from Vancouver, British Columbia, announce the ascent for the first time of Mount Morrison, the highest mountain in Formosa, by Stoepel, the explorer of the Pic of Orizaba n Mexico.

DR. D. J. LEECH, professor ot materia medica and therapeutics at the Owens College, Manchester, will deliver the address inaugurating the winter session of the Pharmaceutical Society on October 2, and on the occasion the Society's Hanbury medal will be presented to Prof. Albert Ladenburg, of Breslau, for his researches into the chemistry of the atropine alkaloids.

THE "Board of Estimate and Appointment" for the City of New York has set aside 63,000 dollars for the zoological garden in Bronx Park. It is also proposed to raise the appropriation for the American Museum of Natural History from 90,000 to 130,000 dollars annually.

AN appeal has recently been made in the Manchester press, by the President and Secretary of the Manchester Literary and Philosophical Society, for help in restoring the tomb of Dalton the chemist. The appeal is made "to those residents of Manchester, chemists and others, who are interested in the work and fame of John Dalton." It appears that the funds of the Society cannot be used for the purpose, but the Council "have felt that the continued neglect of the resting-place of one of Manchester's greatest worthies would be a scandal and a discredit." The sum of 75*l.* in all is the amount endeavoured to be raised, it being thought that the interest on the sum remaining after the payment of present repairs has been made will suffice for keeping the tomb in repair.

MR. GRIESBACH states in the annual report of the Geological Department of India that last year a find of copper and gold was reported near the village of Rohera, a station on the Rajputana-Malwa Railway, in Sirohi territory. The place had evidently been worked for copper in ancient times, and to a considerable extent, as may be seen from the heaps of copper slag in the vicinity. The old mine had, however, not been sufficiently excavated at the time of the Director's visit to enable him to judge of the extent of the deposit.

A CONSIDERABLE amount of attention has, says the *Journal of the Society of Arts*, been given in France to what may be termed general agricultural education. Agricultural teaching, of a more or less rudimentary order, has been made obligatory at elementary schools, and a small garden for practical illustration has been attached to many of these institutions in rural districts, and the instruction thus given has, it is said, produced most beneficial results. The general instruction is given by departmental professors and special professors, whose duties may be divided into two distinct sections: (1) general instruction of adults—in the service of the Ministry of Agriculture; (2) teaching in the normal schools—in the service of the Ministry of Public Instruction. The tuition for adults takes the form of lectures, delivered in different parts of the department. The lectures are intended to enlighten landed proprietors, farmers, and others as to the best agricultural methods, the applications which can be made of scientific discoveries, &c.; in a word, to assist them in reaping the greatest possible profit from their land. The subjects treated naturally vary greatly according to the needs of the population of each department; the lectures, however, possess one characteristic in common, they are of an essentially "popular" type. The lecturer also, at the close of each lecture, places himself at the disposal of his audience, with the object of advising them individually regarding special questions, and of elucidating any points touched upon in his discourse which they may have failed to grasp. The most powerful aids to this class of teaching are found in the "experimental" and "demonstration" fields. Attention is also called to the agricultural stations and laboratories of the country, which, though not properly coming within the sphere of educational establishments, render considerable service to the agricultural population.

ACCORDING to the *National Geographic Magazine*, forecasts for forty-eight hours in advance, for all States east of the Rocky Mountains, were, for the first time in the history of the Weather Bureau, regularly issued from Washington each night during April of the present year.

ORDERS issued by the Government of India to civil surgeons with entomological proclivities require them "to make collections of mosquitoes and other flies that bite men or animals, in accordance with the instructions contained in Prof. Ray Lankester's pamphlet," with a view of determining the possible connection of malaria with mosquitoes. For the general destructions of mosquitoes several methods have, says the Indian correspondent of the *Lancet*, been tried. In many places the engineer has been successful by draining the marshy areas. In others the use of kerosene by throwing it into the water where it forms a film on the surface has prevented the developing larvæ from reaching the air, and has thus brought about their destruction. A more recent experiment has been the employment of permanganate of potash, which is said to kill the insect in all stages of its development. As this chemical has also been

largely employed for purifying the water of doubtful wells, and especially with the view of protecting against the cholera bacillus, it would seem particularly applicable for use in India.

THE *Times* of Monday published a very interesting account of a visit paid by Dr. Karl Peters last April to some ruins near the river Muira, a southern tributary of the Zambesi, in Portuguese territory, nearly opposite Shupanga. The explorer made his journey in consequence of a passage in the *Atlas Historique*, which is to the effect that half a day's journey from the river Mansoro is the fort of Massapa, and near this is the great mountain of Fura, very rich in gold, in which are Cyclopean ruins. It was to find these ruins that Dr. Peters, accompanied by Mr. Leonard Puzey and Mr. Ernest Gramann, journeyed from the Zambesi. After recounting incidents of the journey, the writer says the decisive discovery for the exploration was made by Mr. Puzey on April 20. The ruins are situated on the hill which runs parallel to Mount Peters, and are about two miles distant from Inja-ka-Fura. Dr. Peters' description of his discovery is as follows: "We discovered . . . another ground-wall which had undoubtedly been a part of a building, maybe a temple, maybe a storehouse. This wall had been worked into the natural rock, which here forms a sort of flat floor. The stones of this ground-wall, samples of which I have sent to London, are heart-shaped, and are worked with a pick, so that the description in our old report saying the stones were not worked with a pick apparently only applies to the outer walls. Perhaps the author never took the trouble to visit one of the ruins. I laid bare a part of this ground-wall on the top, but gave up further digging because I was afraid that my clumsy workmen might do harm to the remains. They have, indeed, already destroyed part of the ground-wall. The stones of the wall are a pseudomorph sandstone, while the rock into which they are worked is quartzitic slate. The whole of the ruin is built after the general ancient Semitic pattern. The Cyclopean wall skirts the hill about halfway between the bottom and the top; on the top the buildings, the hoarding-place, and likely the temple were standing. The remains of a ground-wall along the edge of the top lead me to believe that a second wall formerly ran round the platform itself. To explore the ruin properly it will be necessary to send a scientific expedition with a proper outfit for such excavations. The débris have to be removed, and this I am sure will take a considerable time. Why the old conquerors chose this spot for their fort is easy to see. The Muira touches the bottom of the hill, so water was handy. A second river we have discovered at the back of the ruin. From the top they had an outlook over the wide plain before them, while they had the bulk of the Fura massive at their back. From their fort they commanded the plain as well as the mountain. I have called the hill on which the ruin stands after its discoverer 'Puzey Hill.' Mr. Puzey some days later found a second ruin west-north-west of the first on another head of the same ridge looking over the plain in the same direction. I am certain we shall find still more of these Cyclopean buildings when our time, which now is otherwise occupied, permits of a more extended exploration."

THE *British Central Africa Gazette* for May 24, which has just reached us, says "from time to time it has been rumoured that giraffes existed in British Central Africa, on the Loangwa River, but, although that river valley has been frequently visited during the last ten years by Europeans, no authentic information on the point has ever been obtained. Last month, however, a giraffe was shot on the east bank of the Loangwa in the Marimba district by a European prospector, and its skin (incomplete) sent in to Captain Chichester in Mpezeni's country. The hinder half of the skin is being sent to the British Museum, and it is hoped that a complete specimen may be now obtained. The existence of giraffe in Marimba is remarkable: the area in which they are found is extremely restricted, and their number appears to be very few. The one shot, however, was in a herd of about thirty-five. The nearest country north of Marimba in which giraffe are known to exist is north of Mareres, where the Elton-Cotterill Expedition met with them (many years ago). To the south, Matabeleland is the nearest giraffe country."

THE same number of the *Gazette* states that there seems to be no further decrease in the number of elephants still existing in the Protectorate; indeed, the natives round about Domwe have been complaining to the Acting Collector of the damage done in their food plantations by these animals.

IN the Johns Hopkins University *Circulars* for June 1899 a number of notes from the physical laboratory are published under the editorship of Prof. Joseph S. Ames. These comprise a short paper on the effect of temperature, pressure, and used solutions on the deposit of silver voltameters, by J. F. Merrill; notes on the energy-spectrum of a black body, and on the absorption of ice in the ultra-red, by F. A. Saunders; on the Zeeman effect, by H. M. Reese; on electric absorption in condensers, by L. M. Potts; on transference of heat in cooled metals, and on a method of measuring the frequency of alternating currents, by Carl Kinsley. A list of publications in the department of physics, by those who are now or who have been members of the University, is appended. This list, which represents roughly a year's work, occupies three columns, and includes over ninety works and papers by sixty authors. Similar notes and lists from the department of history and politics also appear in the same number, under the editorship of Prof. Herbert B. Adams.

THE *Berichte der Naturforschenden Gesellschaft* of Freiburg (Baden) contains several papers of interest to physicists. Kathode and Röntgen rays form the subject of a discourse by L. Zehnder, who deals somewhat fully with the theory of fluorescence; Prof. F. Himstedt describes apparatus for illustrating lecture experiments on Hertzian waves and on Marconi's telegraphy, and also writes on point-discharges in high-frequency currents. Of biological interest in the same number are Prof. G. Steinmann's notes on the formation of dark pigment in mollusca, and on *Boueina*—a genus of fossil algæ, and August Grüber's note on green *Amoebae*.

A GOOD work is being done in Italy by the "Valle di Pompei," an institution in the province of Naples for rescuing and educating the children of prisoners and criminals. Apart from the philanthropic aspect of this undertaking, the *Report* contains statistics of interest to anthropologists, criminologists, and those who make a study of heredity. It would appear that under the salutary influence of their environment the children of the worst criminals often take a prominent place in the matter of good conduct and diligence.

THE U.S. Weather Bureau has issued a very useful pamphlet (*Bulletin* No. 26) entitled "Lightning and the electricity of the air," by A. G. McAdie and A. J. Henry. The work is divided into two parts: Part 1 deals with the electrification of the atmosphere and the best methods of protecting life and property from lightning, being to a large extent a revision of *Bulletin* No. 15—"Protection from lightning." Part 2 gives statistics of actual losses of life and property sustained in the United States during 1898. The principal facts of the paper are drawn from articles by the authors in various magazines, with the object of furnishing information of practical value generally, especially to those who may have occasion to seek protection from lightning. The work contains interesting particulars relating to the electrical potential of the upper air, as manifested by kite experiments and auroral displays.

THE Pilot Chart of the North Atlantic Ocean for July, issued by the Hydrographic Office of Washington, contains an article on tropical cyclonic storms or West India hurricanes which are prevalent at this season of the year. From a table showing the number of storms experienced between 1885 and 1898, it is seen that the greater number occur between August and October. The nature and mean path of the hurricanes are exhibited by a diagram. In its earlier stages, the centre of the path of the storm has a certain amount of westing, due to the general westward motion of the atmosphere in the low latitudes in which the storm originates, and the whirl is small, probably less than 100 miles in diameter, but its growth is rapid, so that in the middle and higher latitudes it may attain a diameter of 500 or even 1000 miles. The velocity of progression along the track of the disturbance reaches from twenty to thirty miles an hour in high latitudes, while the velocity of the whirl itself, in a direction against the hands of a watch, attains the force of a hurricane.

THE interesting and useful "Glossary of Popular Local and Old-fashioned Names of British Birds" contained in "A Dictionary of Bird Notes," by Mr. Charles Louis Hett, has been issued separately by Jackson, of Brigg.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Miss Nesta Bevan; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, presented by Mrs. K. E. Mackenzie; two Campbell's Monkeys (*Cercopithecus campbelli*, ♂ ♀) from West Africa, presented by Captain F. R. B. Parmeter; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, an Arabian Gazelle (*Gazella arabica*) from Arabia, presented by Mr. B. T. Ffinch; two Common Foxes (*Canis vulpes*) from Russia, presented by Mr. A. H. Britten; an Arctic Fox (*Canis lagopus*) from Iceland, presented by Mr. M. Magnusson; five Common Hedgehogs (*Erinaceus europaeus*), European, presented by Mr. Geo. Long; three Chipping Squirrels (*Tamias striatus*) from North America, presented by the Rev. A. E. Tollemache; a Common Peafowl (*Pavo cristatus*, ♂) from India, presented by Miss A. S. Heldmann; two Climbing Anabas (*Anabas scandens*) from India, presented by Mr. P. Barford; two Rheas (*Rhea americana*, white var.) from Argentina, two Syrian Bulbuls (*Pycnonotus xanthopygos*) from Syria, an European Pond Tortoise (*Emys orbiculare*), European, deposited; two Rose-coloured Pastors (*Pastor roseus*), two Indian Mynahs (*Acridotheres ginginianus*) from India, two Bamboo Partridges (*Bambusicola thoracica*) from Northern China, two Lunulated Honey-eaters (*Melithreptes lunulatus*), two Pied Grallinas (*Grallina australis*), two Musky Lorikeets (*Glossopsittacus concinnus*) from Australia, purchased; a Japanese Deer (*Cervus sika*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

TEMPEL'S COMET 1899 *c* (1873 II.).

Ephemeris for 12h. Paris Mean Time.

1899.	R.A.	Decl.	Br.
	h. m. s.	° ′ ″	
July 20 ...	20 39 34·3 ...	−18 4 26 ...	3·570
21 ...	40 46 1 ...	18 37 9	
22 ...	41 57·9 ...	19 10 4	
23 ...	43 9·5 ...	19 43 9 ...	3·662
24 ...	44 21·1 ...	20 16 22	
25 ...	45 32·6 ...	20 49 38	
26 ...	46 44·0 ...	21 22 55	
27 ...	20 47 55·4 ...	−21 56 9 ...	3·698

HOLMES' COMET 1899 *d* (1892 III.).—Prof. C. D. Perrine gives full details of his rediscovery of the comet in *Astr. Journal*, No. 465. It was found with the 36-inch refractor, using a power of 270. It appeared as a round nebulous mass about 30″ in diameter, with only a slight brightening at the centre. The conditions were good, the sky being very clear and the star images steady. The object was very faint, not brighter than 16 mag., and very difficult to observe, so that the probable error of observation of its place was larger than usual.

DYNAMICAL THEORY OF NEBULÆ.—In No. 465 of the *Astronomical Journal*, Dr. E. J. Wilczynski gives an extended explanation of a dynamical theory of ring and spiral nebulæ which he first brought forward in 1896 (*Astro.-Phys. Journal*, vol. iv. p. 97, 1896). He starts with the assumption that the primordial nebula exists either as an assemblage of meteorites or as a gaseous mass obeying the laws of hydrodynamics. Then, in some unexplained way, each particle is to describe a circular orbit about the common centre of gravity, at which point there may or may not be a condensation. Such an arrangement is not necessarily stable, the limit depending on the relative ratios of the masses and distances of the individual particles, and the ratio of the mass of the central controlling body to its distance from the swarm. If these conditions allow stability the body may condense to a star, single or double. If the system be unstable, however, then on applying Kepler's third law to the revolving particles it is found that the inner members, owing to their greater angular velocity, constantly advance with respect to the outer ones, and after an interval the particles originally lying along a *radius* of the swarm will be drawn out into a spiral curve, as is actually the case in the bodies known as spiral nebulæ. According to this view, the *age* of a nebula would be to some extent indicated by the *number of its coils*, and the author gives an interesting suggestion that this might be investigated by a minute comparative examination of all photographs of spiral nebulæ of different dates. The paper concludes by indicating the possibility of determining the *law of rotation* of these bodies by a combination of spectroscopic and photometric observations.

THE NATAL OBSERVATORY.—The annual report of Mr. E. Nevil, Government Astronomer of the Natal Observatory at Durban, consists chiefly of the detailed meteorological observations made at the institution. The staff consists of the director, one senior astronomical assistant, one junior astronomical assistant, and one meteorological assistant. The astronomical equipment includes an 8-inch Grubb equatorial refractor, a 3-inch Troughton and Simms transit instrument, sidereal and mean time clocks, 3-inch portable equatorial refractor, and an automatic signal transmitter and recorder. Owing to a reduction in the vote to the observatory, much of the work has had to be put aside.

The system of time signals established over the Colony has been carried on without alteration, this being facilitated by the erection of new wires. Since the appointment of the astronomer in 1882 there has been no official residence, the computations, &c., having been mostly made in the open air.

This is at last to be remedied by the erection of a residence, all the fixtures, water supply, &c., however, being provided by the astronomer himself.

TEMPERATURE CHANGES IN YERKES OBJECT-GLASS.—Prof. Barnard has several times made series of measures with the large telescope to find if the changes produced in the instrument by variations in temperature were of sufficient amount to necessitate their consideration in delicate investigations. During the last year observations have been made of the focus at temperatures varying from −22° F. to +80° F., the range thus being 102° (*Astr. Journal*, No. 462). The means of the observations made on nineteen nights show a marked difference in the focus, and it was found that the object-glass shortened 0·26 inch more than the steel tube which carried it. Micrometric measures of the difference in declination between the stars *Atlas* and *Pleione* of the Pleiades showed a decrease of nearly 0″·2 (from 0″·676 during July–September to 0″·491 during January–February).

From the result of these experiments Prof. Barnard thinks that for exact work, such as parallax, with a large glass in a variable climate, these minute changes ought to be determined and taken into account.

In addition to these visual observations, careful determinations of the changes in the colour-curve during wide extremes of temperature are being carried on by Prof. Frost and Mr. Ellerman.

THE REASON FOR THE HISSING OF THE ELECTRIC ARC.[1]

HISSING is one of the few phenomena connected with the electric arc with which every one is more or less familiar. In the old days the sudden, almost complete, extinction of the light of an arc-lamp, and the loud hiss accompanying its relighting, was so common an occurrence that it was supposed by the lay mind to form part and parcel of the working of the "electric light," and led to a lively prejudice against that light on the part of the public. In these days of enclosed arcs and of better constructed lamps, such little interludes are of far less frequent occurrence; but it is as important as ever, from a scientific point of view, to discover their origin, and even from the practical side anything which points to a remedy for this grave defect in arc-lighting cannot fail to be of interest.

The object of the present article is to explain the cause of hissing in direct current open arcs; that is to say, in arcs in which the current flows always in one direction, and to which the air has free access at every point.

There are other ways in which a change taking place in the arc may manifest itself, in addition to giving out sounds of various kinds or by becoming silent. For example, there may be changes in its electrical measurements, or an alteration in the appearance of the crater, the arc, and the carbons.

The sounds given out by the *direct current open* arc are many and various, but only two seem to possess much significance—the hum and the hiss—and the causes of these are evidently connected with one another, for the hum never occurs except when the arc is on the point of hissing or has just been hissing, although it is quite possible to make an arc hiss and become silent again without any hum being heard either before or after.

The hum is a distinct musical note, which is often quite low to start with, and gets higher and higher, till it finally rises to a shriek, and then the arc breaks into a loud hiss, giving forth a sound something like that of steam under pressure, issuing from a pipe. This sound is accompanied by a diminution of about ten volts in the P.D., or electric pressure between the carbons, and an increase in the current.

For the experiments on which the present article was based, three sets of electrical measurements were made, viz. measurements of the current, the P.D. between the carbons, and the length of the arc. Before each observation was made the current and length of arc were kept *rigorously* constant for a sufficient length of time for the carbons to take their characteristic shape for that particular current and length of arc, and long enough, therefore, for the P.D. to have become constant also. Such an arc is called a *normal* arc, as contrasted with one arrived at in a haphazard fashion by suddenly giving the current some particular value and the arc some particular length, and making observations without allowing time for the carbons to acquire their proper forms.

The carbons used were generally both *solid*, that is, neither had a soft core such as is usually given to the positive carbon when the arc is employed for lighting purposes, and they were, as usual, placed vertically over one another with the positive carbon on top.

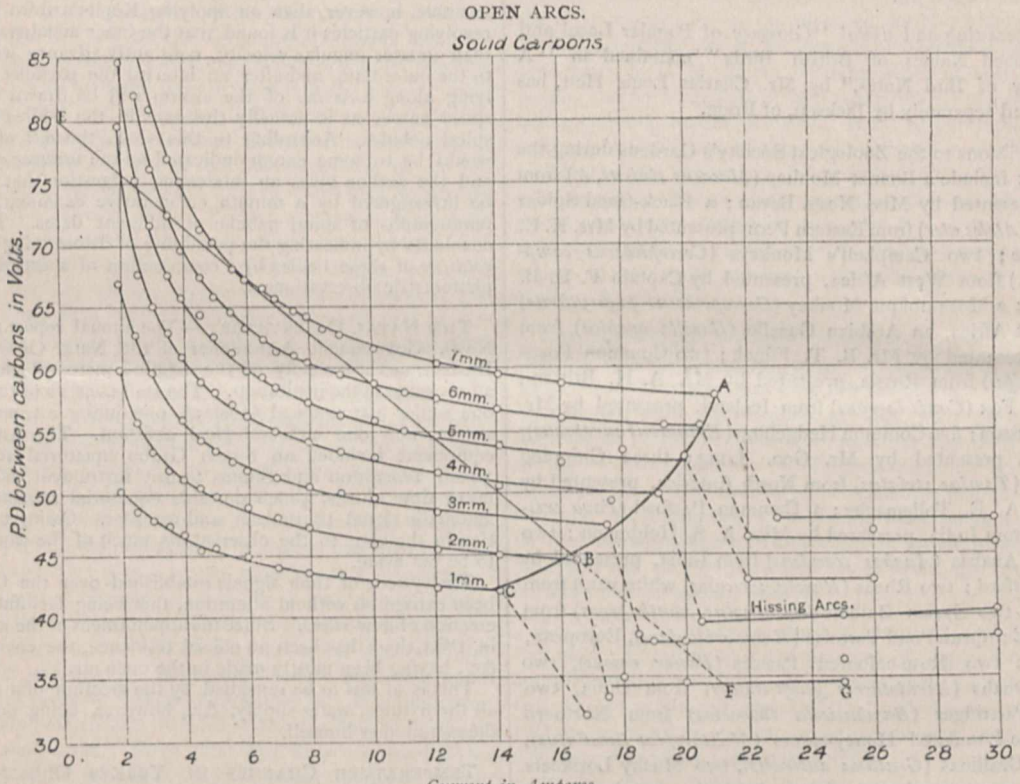

FIG. 1.—Curves connecting P.D. and Current for Constant Length of Arc.
Carbons:—Positive, 11 mm.; Negative, 9 mm.

Some of the results of these experiments are given in Fig. 1, in which the curves connect the P.D. between the carbons with the current, for various constant lengths of arc. Starting from the left, each curve goes smoothly on its way, as the current increases, till a certain point is reached, when it suddenly breaks down, and is continued in a straight line far below and to the right of its own lowest point. The break-down occurs when the current has such a value that the arc can no longer remain silent. The dotted lines, which join the *curves* for silent arcs to the *straight lines* for hissing arcs of the same length, indicate ranges of current that will not flow through the particular length of arc indicated at all if the arc is normal with the arrangement of the circuit existing when the experiments were made.

An examination of these curves shows that with the carbons used, and with the *normal* arc, the following results are met with:

[1] Based on a paper read before the Institution of Electrical Engineers by Mrs. W. E. Ayrton.

(1) When the length of the arc is constant and the arc is silent, it may be made to hiss by increasing the current sufficiently.

(5) For the hissing arc the P.D. is constant for a given length of arc, whatever the current.

It was Niaudet (*La Lumière Electrique*, 1881, vol. iii. p. 287)

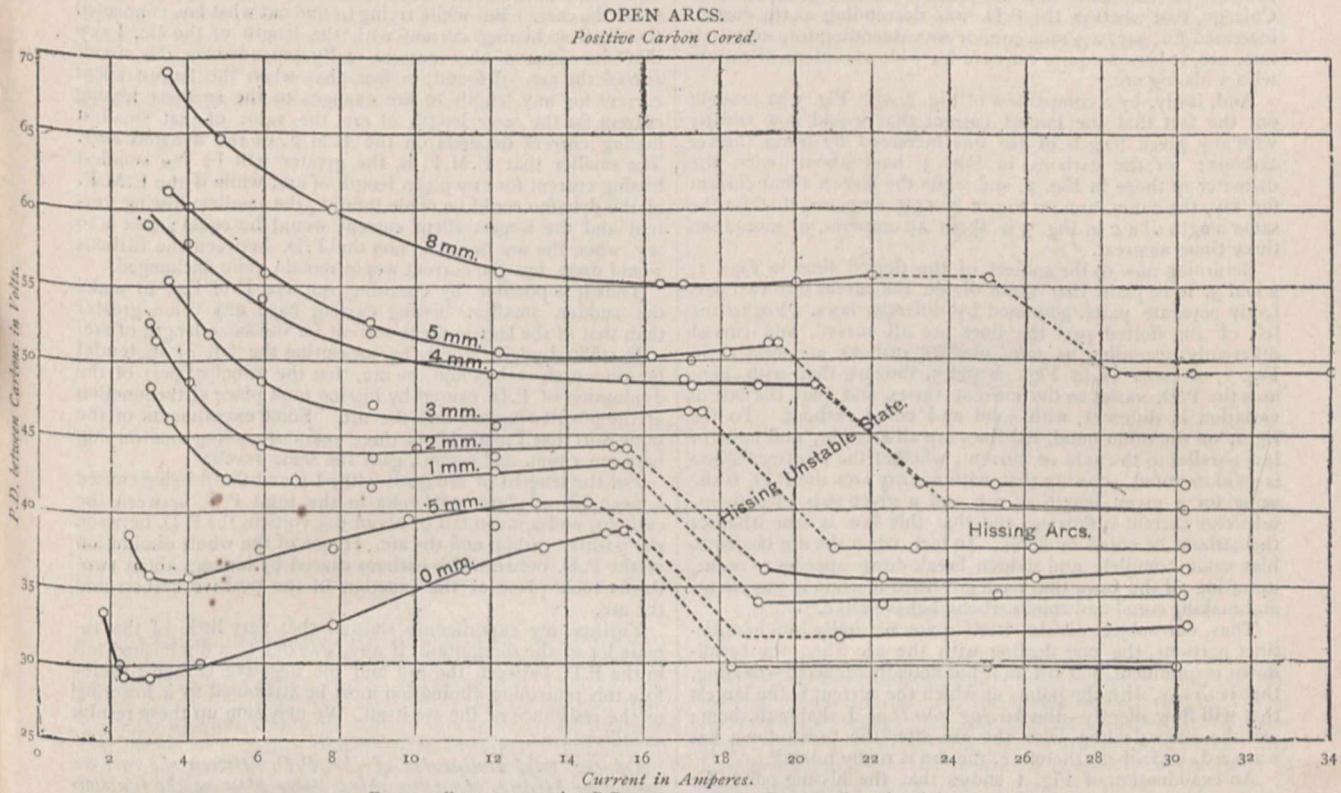

FIG. 2.—Curves connecting P.D. and Current for Constant Lengths of Arc.
Carbons :—Positive, 9 mm. Cored. ; Negative, 8 mm. Solid.

(2) When the current is constant and the arc is silent, *shortening* the arc will make it hiss.

(3) The largest current that will maintain a *silent* arc is greater the longer the arc.

who, in 1881, first observed the fall of about 10 volts in the P.D. between the carbons at the moment hissing began, and, although perhaps there is even yet a lingering notion that it is only when an arc is short that it can hiss, I find that as far back

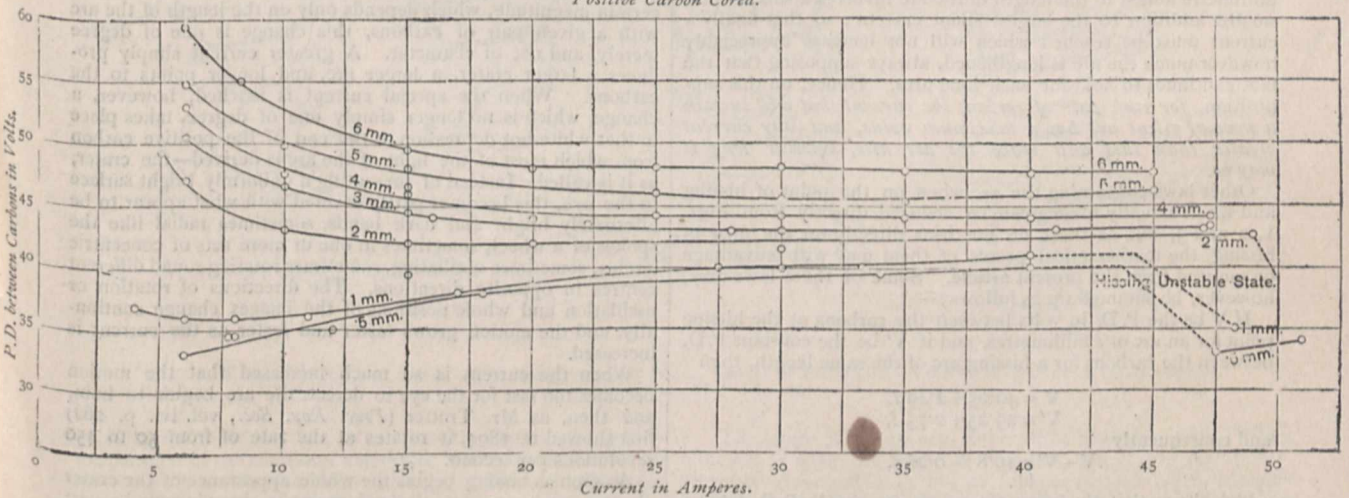

FIG. 3.—Curves connecting P.D and Current for Constant Lengths of Arc
Carbons :—Positive, 18 mm. Cored. ; Negative, 15 mm. Solid.

(4) When the arc begins to hiss, the P.D. suddenly falls about 10 volts and the current suddenly rises two or three amperes.

as 1889 Luggin (*Wien Sitzungsberichte*, 1889, vol. xlvii. p. 118) showed that, however long an arc might be, it would still hiss were the current increased sufficiently.

At the Congress at Chicago in 1893 Prof. Ayrton (*The Electrician*, 1895, vol. xxxiv. pp. 336-7) first drew attention to the region of instability indicated by the dotted portions of the curves. At the same time he pointed out in Fig. 2, shown at Chicago, that whether the P.D. was descending as the current increased for, say, a 4 mm. arc, or was ascending for, say, a 0·5 mm. arc, it became quite constant for wide variations of current with a hissing arc.

And, lastly, by a comparison of Fig. 2 with Fig. 3 he brought out the fact that the largest current that would flow silently with any given length of arc was increased by using thicker carbons; for the carbons in Fig. 3 have about twice the diameter of those in Fig. 2, and while the largest silent current for, say, the 2 mm. arc in Fig. 2 is 15·5 amperes, that for the same length of arc in Fig. 3 is about 49 amperes, or more than three times as great.

Returning now to the subject of the dotted lines in Figs. 1, 2 and 3, it is plain that these divide the curves into two perfectly separate parts, governed by different laws. For to the left of the dotted part the lines are all curved, and curved differently according as *solid* positive carbons are used as in Fig. 1, or *cored* as in Figs. 2 and 3, showing that with silent arcs the P.D. varies as the current varies, and that the law of variation is different with solid and cored carbons. To the right, on the other hand, the lines are all straight, and more or less parallel to the axis of current, whether the positive carbon is solid or cored, showing that with *hissing* arcs the P.D. is the same for a given length of arc and a given pair of carbons, *whatever* current is flowing, and that this law is true whether the carbons be cored or solid. In fact, when the arc begins to hiss some complete and sudden break-down appears to occur, upsetting all the laws that have governed it while it was silent, and making cored and solid carbons behave alike.

Thus, our subject divides itself quite naturally into two distinct portions, the one dealing with the arc when the break-down is imminent, but before it has actually occurred—dealing, that is to say, with the points at which the current is the largest that will flow silently—the *hissing points* as I shall call them; and the other dealing with the arc after the break-down has occurred, and when, therefore, the arc is really hissing.

An examination of Fig. 1 shows that the hissing points lie well on the curve A B C; that curve may, therefore, be taken to embody the laws connecting the P.D. between the carbons, the current, and the length of the arc, at the *hissing points*, for at least all those lengths of arc given by the curves in Fig. 1. The most important of these laws concerns the current at the *hissing point*, the largest *silent* current.

It is quite plain, from Fig. 1, that although this current increases as the length of the arc increases, yet it does not increase at the same rate as the length of the arc. For each millimetre added to the length of the arc involves a smaller and smaller addition to the largest silent current; so that finally a current must be reached which will not increase appreciably however much the arc is lengthened, always supposing that the law continues to hold for such long arcs. Hence, on this supposition, *for each pair of carbons the current that will sustain a normal silent arc has a maximum value, and any current greater than this will make the arc hiss, however long it may be.*

Other laws concerning the arc when on the point of hissing and when actually hissing can be deduced directly from Figs. 1, 2 and 3, but as these do not bear directly on the *cause* of hissing, the mathematical proofs of them may with advantage be omitted from the present article. Some of these laws may, however, be summed up as follows:—

If V be the P.D. in volts between the carbons at the hissing point for an arc of l millimetres, and if V′ be the constant P.D. between the carbons for a hissing arc of the same length, then

$$V = 40{\cdot}05 + 2{\cdot}49\,l,$$
$$V' = 29{\cdot}25 + 2{\cdot}75\,l,$$

and consequently

$$V - V' = 10{\cdot}8 - 0{\cdot}26\,l,$$

which shows that *the longer the arc the less is the P.D. between the carbons diminished when it changes from silence to hissing.*

The numerical coefficients in the above equations naturally refer only to the carbons I used in my experiments, but the *laws* expressed by the equations must be true for *all* direct current open arcs of lengths not differing very greatly from those I used, and burning between solid carbons.

From Fig. 1 it might be supposed that, given the length of the arc, the increase of current that abruptly occurs on the arc starting hissing was as definite for that length of arc as the diminution in the P.D. And this, for a long time, I imagined to be the case. But while trying to find out what law connected the smallest hissing current with the length of the arc, I saw that the value of that current really depended on the circuit *outside* the arc. I found, in fact, that when the largest silent current for any length of arc changes to the smallest hissing current for the *same* length of arc, the value of that smallest hissing current depends on the E.M.F. of the dynamo *only*. The smaller that E.M.F. is, the greater will be the smallest hissing current for any given length of arc, while if the E.M.F. of the dynamo could be made infinite, the smallest hissing current and the largest silent current would be equal; that is to say, when the arc began to hiss the P.D. between the carbons would drop, but the current would remain quite unchanged.

Thus it is possible, by choosing suitable E.M.F.s, to make the sudden smallest hissing current have any value greater than that of the largest silent current for the same length of arc.

In 1889 Luggin found, by measuring the fall of potential between each carbon and the arc, that the principal part of the diminution of P.D. caused by hissing took place at the junction of the positive carbon and the arc. Some experiments of the same sort that I made about three years ago, using arcs varying between 1 mm. and 6 mm., gave the same result.

For the lengths of arc dealt with, I found that hissing caused a mean fall of about 9·7 volts in the total P.D. between the carbons, and a mean fall of about 6·3 volts in the P.D. between the positive carbon and the arc. Hence of the whole diminution of the P.D. between the carbons caused by hissing, about two-thirds took place at the junction of the positive carbon and the arc.

Further, my experiments showed that very little of the remainder of the diminution, if any, was due to a diminished fall in the P.D. between the arc and the negative carbon; therefore this remaining diminution must be attributed to a lowering of the resistance of the arc itself. We may sum up these results as follows:—

Of the total diminution of the P.D. between the carbons caused by hissing, about two-thirds takes place at the junction of the positive carbon and the arc, and the remaining third seems to be due to a lowering of the resistance of the arc itself.

We now pass from the consideration of the electrical measurements of the arc to the appearance of the crater, arc, and carbons.

Every alteration of the current and of the distance between the carbons naturally produces a corresponding modification of all parts of the arc, but until the value of the current attains a certain magnitude, which depends only on the length of the arc with a given pair of carbons, this change is one of degree merely, and not of character. A greater current simply produces a larger crater, a larger arc, and longer points to the carbons. When the special current is reached, however, a change, which is no longer simply one of degree, takes place in that white-hot depression at the end of the positive carbon from which most of the light of the arc is derived—the crater, as it is called. Instead of presenting a uniformly bright surface to the eye, this becomes partly covered with what appear to be alternately bright and dark bands, sometimes radial like the spokes of a wheel, sometimes in one or more sets of concentric circles, sometimes oscillating, sometimes rotating round different centres in opposite directions. The directions of rotation or oscillation and whole positions of the images change continually, and the motion grows faster and faster as the current is increased.

When the current is so much increased that the motion becomes too fast for the eye to detect, the arc begins to hum, and then, as Mr. Trotter (*Proc. Roy. Soc.*, vol. lvi. p. 262) first showed in 1894, it rotates at the rate of from 50 to 450 revolutions per second.

As soon as hissing begins the whole appearance of the crater changes again; a sort of cloud seems to draw in round a part of it, moving from the outer edge inwards, and varying continually in shape and position. Sometimes but one bright spot is left, sometimes several, but always the surface is divided into bright and dull parts, giving it a mottled appearance, as is slightly indicated in (*b*) Fig. 4. If, then, the current be diminished, so that the arc becomes silent again, the whole

surface of the crater grows dark for an instant, then brightens in spots, and finally becomes bright again all over.

The vaporous arc itself undergoes fewer modifications; it preserves the ordinary characteristics of the silent arc while rotating wheels hold possession of the crater, but, when humming begins, a green light is seen to issue from the crater, and with hissing this becomes enlarged and intensified, till the whole centre of the purple core is occupied by a brilliant greenish-blue light, as is indicated in Fig. 5.

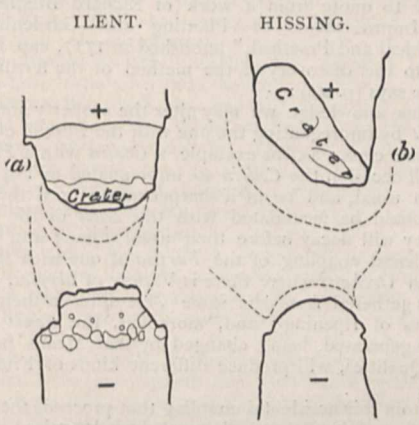

FIG. 4.—Carbons :—Positive, 9 mm. Cored; Negative, 8 mm. Solid. Length of Arc. (*a*) 5 mm., (*b*) 8 mm. Current (*a*) 3·5 amperes, (*b*) 34 amperes.

M. Blondel, whose accuracy of observation and originality in experiment have added so much to our knowledge of the arc, first mentioned a very curious fact about this vapour in 1893 (*The Electrician*, 1893, vol. xxxii. p. 170). He noticed that, while the arc was silent, the vapour was quite transparent, so that, when viewed at a proper angle, the crater could be seen through it perfectly; but that, as soon as hissing began, the vapour became so opaque as to completely hide the crater.

In any case, however, M. Blondel's theory of a change from vapour to solid particles in the arc when hissing begins seems to me to be hardly tenable, if only for the following reason. Whenever we put solid carbon into the arc, such, for instance, as a very thin carbon rod, it glows far more brilliantly than the surrounding vapour, and hence increases the luminosity of the arc. If, therefore, hissing is accompanied by a substitution of solid particles for the vapour of the arc, the luminosity of the arc should *increase* with hissing. But, M. Blondel mentions, in the same article, that the intrinsic brilliancy of the arc *diminishes* when hissing begins, hence the theory of a disruptive discharge of solid particles does not appear to cover the facts.

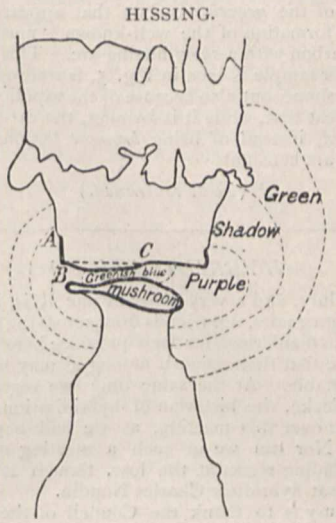

FIG. 5.—Carbons :—Positive, 11 mm. Solid; Negative, 9 mm. Solid. Length of Arc, 1·5 mm. Current, 28·5 amperes.

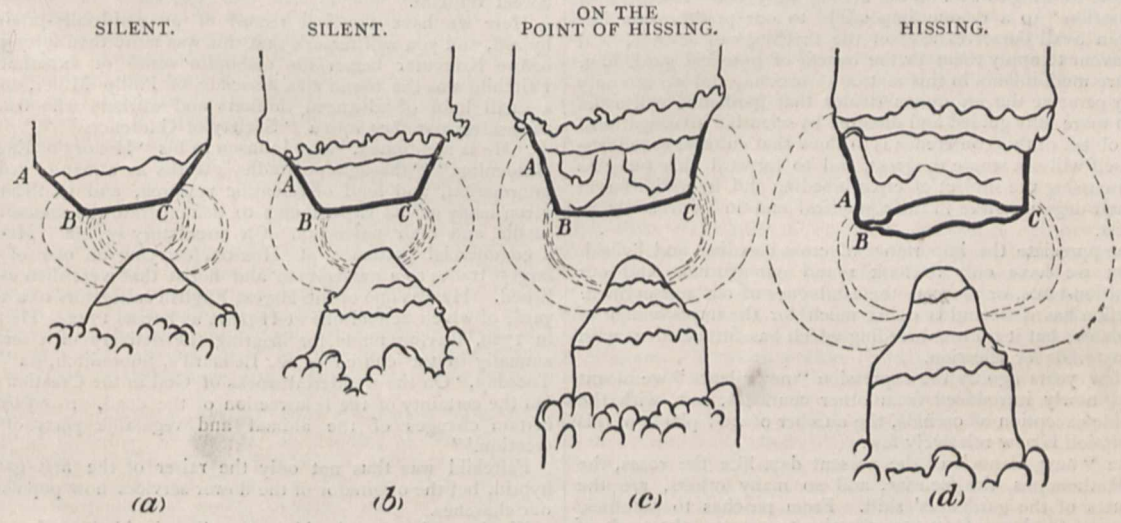

FIG. 6.—Carbons :—Positive, 11 mm. Solid; Negative, 9 mm. Solid. Length of Arc, 2 mm. Current, (*a*) 6 amperes, (*b*) 12 amperes, (*c*) 20 amperes, (*d*) 30 amperes.

M. Blondel believes that, when hissing begins, the gentle evaporation of the carbon of the crater, which feeds the column of vapour in the silent arc, gives place to a disruptive discharge of solid particles torn from the crater.

I have found the opacity of the hissing arc less complete and less invariable than M. Blondel, probably because my conditions were different from his. Indeed I have often been able to see the crater of a hissing arc through the vapour as clearly as if the arc were silent.

The *shape* of the arc also alters when hissing begins. When the arc is silent its shape is rounded, and it has an appearance of great stability; but as soon as hissing occurs, it seems suddenly to dart out from between the carbons and to become flattened out, as if under the influence of a centrifugal force acting at right angles to the common axis of the two carbons. In Fig. 5 and in (*d*) Fig. 6, this flattened appearance is well marked; and indeed these figures show that every part of the vaporous arc itself is involved in this flattening—the purple core-

the shadow round it, and the green aureole—as if they were all revolving with great rapidity round a common axis. And what more likely than that this should be the case, since, as has already been mentioned, the arc is revolving at the rate of 450 revolutions per second *at the moment that it starts hissing?*

As regards the carbons themselves, the only important modification of the *negative* carbon that appears to be due to hissing is the formation of the well-known "mushroom" at the end of that carbon with a *short* hissing arc. This mushroom, of which a good example is seen in Fig. 5, is well named, not only because of its shape, but also because of the rapidity of its growth, which is so great that, while it is forming, the carbons often have to be *separated*, instead of being *brought together*, to keep the length of the arc constant.

(*To be continued.*)

HYBRIDISATION.[1]

OUR first duty, and a very pleasant one it is, is to welcome our foreign guests, our friends from across the sea, as I prefer to call them, to thank them for their presence here to-day, and to express a hope that their sojourn among us may be both agreeable and profitable. At the same time we regret that some, such as Dr. Focke, the historian of hybridisation, has not been able to preside over this meeting, as we had hoped he might have done. Nor can we at such a meeting do other than express our abiding regret at the loss, though at an advanced age, of the great hybridiser Charles Naudin.

Our next duty is to thank the Council of the Royal Horticultural Society for this opportunity of meeting once more in these time-honoured gardens to discuss what I venture to think is one of the, if not the most, important subject in modern progressive experimental horticulture. I use the words progressive and experimental because I believe that the future of horticulture depends very greatly on well-directed experiment.

So far as the details of practical cultivation are concerned, we are not so much in advance of our forefathers. We have infinitely greater advantages, and we have made use of them, but if they had had them they would have done the same. We are able to bring to bear on our art not only the "resources of civilisation" to a degree impossible to our predecessors, but we can avail ourselves also of the teachings of science, and endeavour to apply them for the benefit of practical gardening. We are mere infants in this matter at present, and we can only dimly perceive the enormous strides that gardening will make when more fully guided and directed by scientific investigations. One object of this conference is to show that cultural excellence by itself will not secure progress, and to forward this progress by discussing the subject of cross-breeding and hybridisation in all their degrees, alike in their practical and in their scientific aspects.

To appreciate the importance of cross-breeding and hybridisation we have only to look round our gardens and our exhibition-tents, or to scan the catalogues of our nurserymen. Selection has done and is doing much for the improvement of our plants, but it is cross-breeding which has furnished us with the materials for selection.

A few years ago by the expression "new plants" we meant plants newly introduced from other countries, but, with the possible exception of orchids, the number of new plants of this description is now relatively few.

The "new plants" of the present day, like the roses, the chrysanthemums, the fuchsias, and so many others, are the products of the gardeners' skill. From peaches to potatoes, from peas to plums, from strawberries to savoys, the work of the cross-breeder is seen improving the quality and the quantity of our products, adapting them to different climates and conditions, hastening their production in spring, prolonging their duration in autumn.[2] Surely in these matters we have outdistanced our ancestors.

But let us not forget that they showed us the way. I do not propose to dilate on the share which Camerarius, Millington, Grew, Morland, and others, at the close of the seventeenth century had in definitely establishing the fact of sexuality in plants, but I do wish to emphasise the fact that it was by experiment, not by speculation, nor even by observation, that the fact was proved, and I do wish to show that our English gardeners and experimenters were even at that time quite aware of the importance of their discovery, and forestalled our Herbert and Darwin in the inferences they drew from it. In proof of which allow me to quote from a work of Richard Bradley, called "New Improvements of Planting and Gardening, both Philosophical and Practical," published in 1717, cap. ii. After alluding to the discovery of the method of the fertilisation of plants, he says (p. 22):—

"By this knowledge we may alter the property and taste of any *Fruit* by impregnating the one with the *Farina* of another of the same class; as, for example, a *Codlin* with a *Pearmain*, which will occasion the *Codlin* so impregnated to last a longer time than usual, and be of a sharper taste; or if the *Winter Fruits* should be fecundated with the *Dust* of the *Summer kinds*, they will decay before their usual Time; and it is from this accidental coupling of the *Farina* of one with the other, that in an *Orchard* where there is Variety of *Apples*, even the *Fruit* are gathered from the same *Tree* differ in their Flavour and Times of ripening; and, moreover, the *Seeds* of those Apples so generated, being changed by that Means from their Natural Qualities, will produce different kinds of Fruit if they are sown.

"'Tis from this accidental coupling that proceeds the numberless varieties of Fruits and Flowers which are raised every day from *Seed*. . . .

"Moreover, a curious Person may by this knowledge produce such rare kinds of *Plants* as have not yet been heard of, by making choice of two *Plants* for his Purpose, as are near alike in their Parts, but chiefly in their *Flowers* or *Seed* vessels; for example, the Carnation and Sweet William are in some respects alike, the *Farina* of the one will impregnate the other, and the *Seed* so enlivened will produce a *Plant* differing from either, as may now be seen in the garden of Mr. *Thomas Fairchild*, of *Hoxton*, a plant neither *Sweet William* nor *Carnation*, but resembling both equally, which was raised from the *seed* of a Carnation that had been impregnated by the *Farina* of the Sweet William."

Here we have the first record of an artificially-produced hybrid, and you will remark that this was more than forty years before Kolreuter began his elaborate series of experiments. Fairchild was the friend and associate of Philip Miller, and of a small knot of advanced thinkers and workers who banded themselves together into a "Society of Gardeners."

"He is mentioned," says Johnson in his "History of English Gardening," "throughout Bradley's works as a man of general information, and fond of scientific research, and in them are given many of his experiments to demonstrate the sexuality of plants, and their possession of a circulatory system. He was a commercial gardener at Hoxton, carrying on one of the largest trades as a nurseryman and florist that were then established. He was one of the largest English cultivators of a vineyard, of which he had one at Hoxton as late as 1722. He died in 1729, leaving funds for insuring the delivery of a sermon annually in the church of St. Leonard's, Shoreditch, on Whit Tuesday, 'On the wonderful works of God in the Creation; or On the certainty of the resurrection of the dead, proved by the certain changes of the animal and vegetable parts of the creation.'"

Fairchild was thus not only the raiser of the first garden hybrid, but the originator of the flower services now popular in our churches.

We do not hear much of intentionally-raised hybrids from this time till that of Linnæus, in 1759 ("Amœn. Acad.," ed. Gilibert, vol. i. p. 212). The great Swedish naturalist, having observed in his garden a Tragopogon, apparently a hybrid between *T. pratensis* and *T. parvifolius*, set to work to ascertain whether this conjecture was correct. He placed pollen of *T. parvifolius* on to the stigmas of *T. pratensis*, obtained seed, and from this seed the hybrid was produced.

About the same time (that is, in 1760) Kolreuter began his elaborate experiments, but these were made with no practical aim, and thus for a time suffered unmerited oblivion.

Some years after, the President of this Society, Thomas

[1] Substance of the address by Dr. Maxwell T. Masters, F.R.S., delivered on opening the proceedings of the International Conference on "Hybridisation," Tuesday, July 11.

[2] See some interesting observations of MacFarlane on the period of flowering in hybrids as intermediate between that of the parents, *Gardeners' Chronicle*, June 20, 1891; and on the structure of hybrids, May 3, 1890.

Andrew Knight, and especially Dean Herbert, took up the work, with what splendid results you all know.

It is curious, however, to note that objections and prejudices arose from two sources. Many worthy people objected to the production of hybrids, on the ground that it was an impious interference with the laws of nature. To such an extent was this prejudice carried, that a former firm of nurserymen at Tooting, celebrated in their day for the culture, amongst other things, of heaths, in order to avoid wounding sensitive susceptibilities, exhibited as new species introduced from the Cape of Good Hope forms which had really been originated by cross-breeding in their own nurseries.

The best answer to this prejudice was supplied by Dean Herbert, whose orthodoxy was beyond suspicion. He, like Linnæus before him, had observed the existence of natural hybrids, and he set to work experimentally to prove the justness of his opinion. He succeeded in raising, as Engleheart has done since, many hybrid narcissi, such as he had seen wild in the Pyrenees, by means of artificial cross-breeding. If such forms exist in nature, there can be no impropriety in producing them by the art of the gardener.

In our own time, Reichenbach, judging from appearances, described as natural hybrids numerous orchids. Veitch and others have confirmed the conjecture by producing by artificial fertilisation the very same forms which the botanist described.

It remains only to speak of another respectable but mistaken prejudice that has existed against the extension of hybridisation. I am sorry to say this has been on the part of the botanists. It is not indeed altogether surprising that the botanists should have objected to the inconvenience and confusion introduced into their systems of classification by the introduction of hybrids and mongrels, and that they should object to hybrid species, and much more to hybrid genera; but it would be very unscientific to prefer the interests of our systems to the discovery of the truth.

I may mention two cases where scepticism still exists as to the real nature of certain plants: *Clematis jackmani* of our gardens, raised, as is alleged, by Mr. Jackman, of Woking (*Gardeners' Chronicle*, 1864, p. 825), was considered by M. Decaisne and M. Lavallée[1] to be a real Japanese species, and not a hybrid. This may be so, but there is no absolute impossibility in the conjecture that the Japanese plant and the cultivated plant originated in the same way. Again, Mr. Culverwell's supposed hybrid between the strawberry and the raspberry has been pronounced to be no hybrid, but to be *Rubus leesii*. But what, we may ask, is *Rubus leesii?* It appears to be a sterile form more closely allied to the raspberry than to the strawberry. Is it not at least possible that Mr. Culverwell has produced it artificially?

The days when "species" were deemed sacrosanct, and "systems" were considered "natural" have passed, and Darwin, just as Herbert did in another way, has taught us to welcome hybridisation as one means of ascertaining the true relationships of plants and the limitations of species and genera.

Darwin's researches and experiments on cross-fertilisation came as a revelation to many practical experimenters, and we recall with something akin to humiliation the fact that we had been for years exercising ourselves about the relative merits of "pin eyes" and "thrum eyes" in primroses, without ever perceiving the vast significance of these apparently trifling details of structure.

It would occupy too much time were I to dilate upon the labours of Gaertner, of Godron, of Naudin, of Naegeli, of Millardet, of Lord Penzance, of Engleheart, and many others. Nor need I do more than make a passing reference to the wonderful morphological results obtained by the successive crossings and inter-crossings of the tuberous begonias, changes so remarkable that a French botanist was even constrained to found a new genus, Lemoinea, so widely have they deviated from the typical begonias.

For scientific reasons, then, no less than for practical purposes, the study of cross-breeding is most important, and we welcome the opportunity that this conference affords of extending our knowledge of the life-history of plants, in full confidence that it will not only increase our stock of knowledge, but also enable us still further to apply it to the benefit of mankind.

[1] Lavallée, "Les Clematites à Grandes Fleurs," p. 6 and p. 9, tab. iv.: *Clematis hakonensis*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. A. C. HOUSTON has been appointed Lecturer in Bacteriology at Bedford College, London, for Women.

Dr. W. WACE CARLIER, at present Lecturer on Experimental Physiology and Histology in the University of Edinburgh, has been appointed Professor of Physiology in Mason University College, Birmingham.

THE Royal Commissioners for the Exhibition of 1851 have approved the nomination by the University College of North Wales of Mr. Robert Duncombe Abell to a Science Research Scholarship of the value of 150*l.* a year. Mr. Abell is about to enter the University of Leipzig, where he proposes to engage in a special research under the direction of Prof. Wislicenus.

THE following appointments abroad may be noticed:—Dr. James Ewing to be professor of pathology in the Cornell University Medical College; Dr. Charles W. Wardner to be professor of physics in Williams College; Dr. H. G. Byers to be professor of chemistry in the State University of Washington; Dr. Alfred H. Seal to be professor of chemistry in Girard College, Philadelphia.

THE new buildings of the London Hospital Medical College were opened on Tuesday last. They occupy the site of the old chemical theatre and laboratory, and comprise the following rooms and departments. On the basement is the department of public health, containing a large museum, professors' room, class rooms, &c.; on the ground floor, the biological laboratory, class rooms, and the materia medica museum; on the first floor, the chemical theatre and laboratories, and the balance room; on the second floor, the physics laboratory, the chemical laboratory for the diploma in public health classes, the operative surgery room, and a large anatomy class room leading from the dissecting room. On the third floor is the bacteriological department, with general laboratory, research laboratories, class rooms for public health work, sterilising room, &c. Other portions of the building have thus been left for additional development, and advantage has been taken of this to provide special class rooms for students studying for the preliminary scientific, the intermediate M.B., London, and other examinations. Additions have also been made to the present physiological department, giving rooms for original research and for special class work for the higher examinations. For all these departments special teachers have already been appointed, who are devoting their entire time to the particular subjects that they have undertaken. The new buildings, with their fittings, will cost altogether not less than 10,000*l.*

SCIENTIFIC SERIAL.

Bollettino della Società Sismologica Italiana, vol. v. No. 1, 1899-1900.—The rules of the Society and list of Fellows (forty-three national and ten foreign) are given.—Determination of the epicentre and time at the origin of earthquakes of unknown origin propagated along the earth's surface by means of four or five time-observations, by G. Costanzi. Equations for the above purposes are obtained on the supposition that the surface-velocity is constant.—Vesuvian notices (July-December 1898), by G. Mercalli. A monthly chronicle, with notes on the paroxysm of September, the central crater, and the excentric eruptive apparatus; illustrated by reproductions of two photographs.—Notices of the earthquakes observed in Italy (January 1-February 3, 1898), by G. Agamennone, the most important being the Ferrara earthquake of January 16, a distant earthquake on January 25, and the Asia Minor earthquake of January 29.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 15.—"On the Application of Fourier's Double Integrals to Optical Problems." By Charles Godfrey, B.A.

The disturbance received at any point from a luminous body is a vector, varying with the time. It may be defined by its resolved parts along three rectangular axes; let $f(t)$ be one of these resolutes. In general $f(t)$ will not be a periodic function,

even when the light is approximately monochromatic. By Fourier's theorem of double integrals

$$f(t) = \int_0^{\infty} (C \cos ut + S \sin ut)\, du,$$

where

$$C = \frac{1}{\pi}\int_{-\infty}^{+\infty} f(v) \cos uv\, dv, \quad S = \frac{1}{\pi}\int_{-\infty}^{+\infty} f(v) \sin uv\, dv.$$

This is true provided $f(t)$ is subject to certain conditions, which are proved to be present in any physical problem. The object of the paper is to inquire whether the above theorem justifies us in regarding any plane-polarised plane light motion as equivalent to a combination of simple harmonic vibrations, with periods varying from 0 to ∞. The element of the integral suggests a vibration of amplitude $du\sqrt{C^2 + S^2}$, phase $\tan^{-1}\frac{S}{C}$, and period $\frac{2\pi}{u}$. It is proved that in certain very general cases such an interpretation is possible, notably in the case of "constant" light, such as presents a steady appearance.

This calculus enables us to discuss the width of the lines in the spectrum of an incandescent gas, taking into account not only the velocities of the molecules, but also the effect of collisions, and of radiative damping in the molecular vibrations. The connection between Röntgen rays and ordinary light is examined, J. J. Thomson's theory of the former being assumed. It is shown that perhaps $\frac{1}{1000}$ of the energy of the rays will be in the visible spectrum. The theory of dispersion is considered with reference to natural light as opposed to a simple harmonic train of waves.

PARIS.

Academy of Sciences, July 10.—M. van Tieghem in the chair.—The Perpetual Secretary announced to the Academy the loss it had sustained by the death of Sir William Flower, Correspondent in the Section of Anatomy and Zoology.—Remarks by M. Ed. Perrier on his *Traité de Zoologie*.—New researches on argon and its combinations, by M. Berthelot. Having a larger quantity of argon placed at his disposal, the author has repeated his earlier observations on the reactions between argon and certain organic compounds. Entirely negative results were obtained when mixtures of argon with ethylene, glycollic ether, aldehyde, acetone, amylene, petroleum ether, propionitrile, allyl sulphocyanide, or amylamine were submitted to the prolonged action of the silent discharge, the original volume of argon being recovered unchanged. With benzene, toluene, cymol, turpentine, anisol, phenol, benzaldehyde, aniline, phenyl sulphocyanide, and benzonitrile, on the other hand, an absorption of argon took place in amounts varying from one to six per cent. At the same time a greenish fluorescence appeared, giving a characteristic spectrum.—On the geographical and cartographical work carried out in Madagascar by order of General Gallieni between 1897 and 1899, by M. Alfred Grandidier. The values previously assumed for the latitude and longitude of Tamatave, Andévorante, Fort Dauphin, and other towns in Madagascar are here revised, and the differences tabulated.—On the dialkylbenzoylbenzoic acids and their tetra-chlor-derivatives, by MM. A. Haller and H. Umbgrove. Details are given of the preparation and properties of tetrachlordimethylamidobenzoylbenzoic acid, acetyldimethylamidobenzoyltetrachlorbenzoic anhydride and the corresponding ethyl and methyl ethers, dimethylamidobenzoyltetrachlorbenzoic acid and the anhydride of acetyldiethylamidobenzoyltetrachlorbenzoic acid, together with its ethyl and methyl ethers.—On the development of analytical functions of several variables, by M. Paul Painlevé.—Contribution to the theory of musical instruments, by M. Firmin Larroque.—Remarks on the use of cryohydrates, by M. A. Ponsot.—Action of nitric oxide upon chromous salts, by M. Chesnau. Chromous salts in solution dissolve nitric oxide like ferrous salts, giving only one compound. On heating, or placing in a vacuum, this compound gives off no gas, thus differing from the corresponding ferrous compound.—On metallic sulphantimonites, by M. Pouget. Solutions of potassium sulphantimonites by double decomposition with salts of metals may give salts of the types SbS_3M_3, or SbS_3M_2K, but in no case of the type SbS_3MK_2.—Action of phenylhydrazine upon alcoholic bromides, chlorides, and iodides, by M. J. Allain Le Canu. The iodides behave differently to the corresponding bromides and chlorides in respect to their reaction with phenylhydrazine.—On the aminocampholenes, by MM. E. E. Blaise and G. Blanc.—Contribution to the study of an oxyptomaine, by M. Œchsner de Coninck. The oxyptomaine $C_8H_{11}NO$ was prepared by the action of hydrogen peroxide upon the pyridic ptomaine, $C_8H_{11}N$. In the present paper details are given of its bromohydrate, chloroaurate, and chloromercurate.—New method for the acidimetric estimation of alkaloids, by M. Élie Falières. The titration is conducted with an ammoniacal copper solution instead of litmus or one of the ordinary indicators. The experimental results were very satisfactory.—On benzoyl-furfurane, by M. R. Marquis. Benzoylfurfurane is readily obtained by the interaction of pyromucyl chloride and benzene in presence of aluminium chloride.—The egols, new general antiseptics, by M. E. Gautrelet. Parasulphones derived from phenols are nitrated, and the ortho-nitro-phenolparasulphonate of mercury and potassium prepared from this. The compounds thus obtained are termed egols, phenegol from phenol, cresegol from cresol, and so on, and possess certain advantages as antiseptic agents.—The *rôle* of heat in muscle action, by M. Raphael Dubois.—New observations on echidnase, by M. C. Phisalix. This ferment is present in snake poison, and is found to exert a diastatic action not only upon animal tissues, but even upon the active principle of snake poison, echidnotoxin.—Analogies between cultures of the vegetable fungus *Nectria* and the parasitic fungus in human cancer, by M. Bra.—On the absence of regeneration of the posterior members of the leaping Orthoptera and its probable causes, by M. Edmond Bordage.—On the affinities of *Microsporum*, by MM. L. Matruchot and Ch. Dassonville.—On the cicatrisation of the fascicular system, and of the secretory apparatus on the falling of the leaf, by M. A. Tison.—Barometric deviations on the meridian of the sun at successive days of the synodic revolution, by M. A. Poincaré.—On the use of self-recording meteorological apparatus in captive balloon ascents, by M. Léon Teisserenc de Bort.

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