THURSDAY, MAY 31, 1900.

A LIFE OF SCHÖNBEIN.

Christian Friedrich Schönbein, 1799–1868. *Ein Blatt zur Geschichte des* 19. *Jahrhunderts*. Von Georg W. A. Kahlbaum und Ed. Schaer. I. Theil. Pp. xix+230. (Leipzig: Johann Ambrosius Barth, 1900.)

THIS work forms the fourth part of the series of monographs on the history of chemistry being published under the editorship of Prof. Kahlbaum, of Bâle, whose qualifications for the task have already been made known to English men of science in the notices of two of his earlier volumes published recently in these columns.[1] The present instalment covers the period from the time of Schönbein's birth to the year 1849, and is divided into four sections, which comprise respectively the intervals 1799–1820, the "Wanderjahre" 1820–1828, the residence at Bâle from 1828 till the discovery of the passivity of iron towards the end of 1835, and the prosecution of the researches on the latter subject and on cognate electrical subjects from 1836 till 1849. There is a supplementary section dealing with Schönbein as a teacher and friend, which is by no means the least interesting part of the present volume. A perusal of the work will not only convince its readers that Schönbein was altogether a remarkable man as a thinker and experimenter, but that his personality and work could not have fallen for delineation and estimation into any better or more appreciative hands than those of Dr. Kahlbaum and his colleague.

The subject of the present biography was born at Metzingen, in Schwabia, on October 18, 1799. Passing over his boyhood, it appears that in his fourteenth year he made his first start in life as a pupil in the chemical and pharmaceutical factory of Metzger and Kaiser at Böblingen, so as to become a practical chemist. He suffered much at first from home-sickness, which, the authors tell us, is a purely German ailment:—

"Das bittere Leid des Heimwehs, dieser ächt deutschen Krankheit, die Engländer und Franzosen haben kaum ein eigenes Wort dafür, &c."

After seven years in this factory, he went, in 1820, into Dr. J. G. Dingler's factory for chemical products at Augsburg, on which occasion it is noteworthy that he underwent his only examination, and obtained his only certificate from Dr. Kielmeyer, of Stuttgart. The original document, which has been obtained by Dr. Kahlbaum, testifies that at that time Schönbein was possessed of a good scientific and practical knowledge of chemistry. Dr. Dingler's letter, setting forth the qualifications which he expected on the part of the young man whom he was thinking of engaging, is dated March 20, 1820, and as a revelation of the state of affairs in a German establishment during the early part of the nineteenth century, it will repay careful perusal. The chemist required by him was to have scientific rather than ordinary routine chemical knowledge; he was to have at the same time something more than a superficial acquaintance with chemistry, in order that he might be able to carry out the analytical work required of him; he was to have a knowledge of languages, so as to be able to translate, at least from French; he was to be possessed of moral rectitude, and to be entirely worthy of confidence. He was to come on probation for fourteen days, and if not found suitable he was to be sent back "carriage paid" ("bei Vergütung der Reisekosten"). If found suitable, he was to be boarded and lodged, and to receive from 200 to 300 florins per annum, with an increase to follow.

As the editor points out, Schönbein must have made good use of his time at Böblingen, since he seems to have come up to Dingler's requirements, and was appointed to the Augsburg factory; but before entering upon his duties he drew a fatal conscription number, and had to undergo a short term of military service. It appears, however, that he was soon discharged from this duty, through the intervention of the King, and in May 1820 he was "militärfrei."

The eight years from 1820–28 must have been years of great activity in Schönbein's early life. He remained only a few months at Augsburg, and then travelled from one University to another. His name is associated during this period with the Universities of Tübingen and Erlangen. While studying at the latter place, where he had Liebig for a contemporary, he was also holding the appointment of director in Adam's factory at Hemhofen, but finding that his factory work interfered with the prosecution of a regular course of study at the University, Mr. Adam relieved him of this work, and assisted him pecuniarily by appointing him tutor in his family.

Among many other interesting episodes in Schönbein's career at this period is his sojourn in England, which appears to have been the outcome of a taste for pedagogy inspired by his friend Christian Friedrich Wurm, who subsequently became professor of history in the Hamburg gymnasium—a man of many parts, a master of the English language and an ardent disciple of Pestalozzi, whose works he had translated into English. It was in 1826 that the young Schönbein entered the service of Dr. Mayo, who kept a school at Epsom, where Wurm was already engaged, for the purpose of imparting instruction in mathematics and natural philosophy on Pestalozzian principles in return for "50*l*. sterling per annum; with board, lodging and washing." The description of Dr. Mayo's establishment given by Wurm, and the criticisms which he makes upon the English educational methods of that time, are preserved in a letter to Schönbein written from Epsom in 1825, and published by Dr. Kahlbaum in the present volume. The editor comes to the conclusion that the Epsom academy was as far removed from the ideal Fröbel institute as the classical establishment of Dr. Blimbers at Brighton, in which young Paul Dombey was "forced" to death. Schönbein appears, however, to have made the best of his opportunities while in England, and to have paid visits to London and to Scotland, making friends and acquaintances, and gleaning knowledge wherever he went. In 1827 he left for Paris, and a long extract from his diary of travel, reprinted in the present work, is full of most interesting comparisons of English with French modes of travelling, and of the personal characteristics of the two nations. While Anglophobia, judging from some of the correspondence received by Schönbein at that time,

[1] NATURE, February 8, p. 337; and March 29, p. 513.

appears even then to have existed in Germany, it is satisfactory to learn that he was never influenced by it :—

"Dann war gerade ihm der afflammende Strohfeuerenthusiasmus der Franzosen nicht sympathisch, sein deftiges, bedachtes Wesen war sehr wohl, wir haben das ja gesehen, begeisterungsfähig und hingebend, aber, wie sein Humor nichts von dem sprühenden Feuerwerk französischen Esprits hatte, so wenig trat sein Enthusiasmus als schnell verrauschende Schwärmerei auf. Die langsame niedersächsische Art der Engländer war ihm, dem Schwaben, darum viel herzwärmender als das griechische Feuer der Franzosen."

It is, in fact, quite remarkable to find throughout this biography how warmly Schönbein felt himself in sympathy with England and English people. Faraday, Grove and Graham were his intimate and life-long friends. He appears to have gone to Paris under the same conditions and for the same purpose that he came here—to acquire a more intimate knowledge of the language, and to gain some insight into French pedagogy. The school in Paris, kept by a M. Rivail, in which he temporarily became a teacher, was unsatisfactory from every point of view, and on the whole the young German seems to have had anything but a pleasant time in the French capital about that period. But there, as elsewhere, he made the best of his opportunities by attending lectures at the Sorbonne, where he came under the influence of Gay-Lussac and Thénard, Biot, Dumas, Pouillet, Brongniart, &c., and by the time he returned to England to stay with his friend and Epsom colleague, Barron, at Stanmore, his appreciation of France and the French had considerably increased. Schönbein's views on the nature and constitution of Polytechnics, and his letters to Wurm written from Paris, and giving his experience of the Sorbonne and its professors, are full of interest.

In 1827, Merian, the professor of physics and chemistry at Bâle, was taken ill, and a substitute had to be found to carry on his duties. The post was first offered to Schönbein's friend, Engelhart, then also in Paris, who was unable to accept it, and afterwards to Schönbein, who was in England, and who finally undertook the duties, thus severing himself from this country, apparently to his regret, and becoming attached, in 1828, to that University, on which he ultimately shed such lustre. The first years of his connection with Bâle were unsettled by the provisional character of his appointment, and were further troubled by political disturbances, during which Schönbein himself bore arms, and it was not till February 1832 that he made his first communication to the scientific society of that town. This paper dealt with the classification of the elements into metals and non-metals, the former being defined as those elements which form basic oxides, and the latter those which form acid oxides. A few other papers followed during the years 1833–1835; one on the Pepys gas-holder, one on polarised light, one on an *ignis fatuus* observed at Bärenthal in the Black Forest, and one on the isomerism of chemical compounds. With the clearing of the political atmosphere and the cessation of hostilities, the University of Bâle underwent reorganisation, and Schönbein was appointed ordinary professor of physics and chemistry in 1834. His marriage took place the following year, towards the end of which (December 23, 1835) he made known to the "Naturforschenden Gesellschaft" his memorable work on the behaviour of tin and iron towards nitric acid, later communications on the passive state of iron and other metals having been made on January 21 and March 3, 1836.

The observation which formed the starting-point of Schönbein's researches appears to have been made by many previous investigators, among whom our own countryman, James Keir, F.R.S. (*Phil. Trans.* 1794) is given the priority. The period covered by the next section of the present work, viz. from 1836 to 1849, was full of activity and productiveness on the part of Schönbein, whose development of ideas, from his first experiments on the "passive" state of metals through all their ramifications into the various fields of electro-chemistry, is followed out and set forth by Dr. Kahlbaum with a masterly hand. As we are at this period well within what might be called the public aspect of Schönbein's work, when his results were being continuously published and discussed throughout the scientific world, it is unnecessary to dwell at any greater length upon the contents of the present instalment of his biography. It will interest English readers particularly to find how skilfully the authors trace the influence of Schönbein's correspondents, and particularly Faraday, upon his work. This work centred round the subjects of the origin of the electric current and the polarisation of the electrodes. The great controversy between the "chemical" and the "contact" theories of electromotive force was then raging, and it is now a matter of history how ably and staunchly Schönbein advocated the former. Most clearly are his views expressed in the extracts from his correspondence with Faraday, Poggendorff, Grove, De la Rive and others which the authors have brought together in this biography. Now and again passages occur which are really prophetic, such, for example, as his statement concerning the possible utility of the "Voltaic cell" in organic chemical investigation,[1] and his remarks[2] on the desirability of there being a more frequent blending of physics and chemistry in the same individual, as exemplified by Berzelius, Gay-Lussac, De la Rive, Becquerel, Daniel and Grove. Dr. Kahlbaum points to the modern school of physical chemistry as the embodiment of this wish.

In the concluding section, Schönbein's position in the world of science, as deduced from his own statements, is most instructively summed up. He was something more than a "physicist" or "chemist":—

"Also Schönbein war nichts weniger als ein kritikloser Anhänger der Naturphilosophie im gewöhnlichen Sinne des Wortes, als der er im allgemeinen verschrieen ist, aber er war eine durch and durch philosophisch angelegte Natur mit gefülltem philosophischem Schulsack und gut geschultem Denken, die eben immer aus theoretischen Ansichten heraus ihre Arbeiten unternahm."

This judgment is borne out by an extract relating to his work on ozone contained in a letter written to Liebig in 1866, in which he states that, although the detection of a peculiar smell in electrolytic oxygen was accidental, all that has since proceeded from this observation cannot be ascribed to accident.

[1] *Pogg. Ann.* 1839, xlvii. 583.
[2] *Beiträge zur physikalischen Chemie*, 1844.

Among the many interesting aspects of Schönbein's life and work dealt with in this section is his dislike for organic chemistry already referred to in his correspondence with Faraday. Dr. Kahlbaum, we may add, endorses this opinion with some very strong remarks of his own (pp. 204-205), which will, no doubt, be forgiven by the "Herren Organiker" in view of the very important service to the history of nineteenth century science which he is rendering by these biographical contributions. Then, again, one cannot but be struck by the versatility of Schönbein's genius as revealed by the narration of his connection with journalism. That the illustrious Bâle professor was possessed of great literary power is made clear by his biographer. It is worthy of record that Schönbein attended the Birmingham meeting of the British Association in 1839, and the Cambridge and Southampton meetings in 1845 and 1846; of the first of these he gave an account in his "Reisetagebuch eines deutschen Naturforschers," of which extracts in English were published in the *Athenæum*. As an excellent example of his literary style may be mentioned the charming description of Easter festivities in Germany, written in English to Faraday in 1856. With respect to the literary style and method of publishing his scientific writings, there is a long and interesting critical letter from De la Rive in 1839, in which he reproaches Schönbein for being too diffuse, for writing too much and at too great a length, for introducing too often unverified suppositions, and, in fact, as we should say at the present time, for transferring the contents of his laboratory notebooks to the pages of his published memoirs:—

"C'est une voie tentative, à la tête de laquelle est Faraday dans ce moment, qui publie, publie le journal de ses expériences, aussi voyez le peu d'effet que font ses travaux sur le continent."

This criticism, by the way, is endorsed by Dr. Kahlbaum, who regrets that the Germans, "on account of its foreign origin," should have imitated a style which he characterises as incivility (Unhöflichkeit) to the readers.

Enough has been gleaned from this volume to show our readers that as a contribution to the history of the science of the nineteenth century, it is in no way inferior to its predecessors. R. MELDOLA.

PROFESSOR TAIT'S SCIENTIFIC PAPERS.

Scientific Papers. By Peter Guthrie Tait, M.A., Sec. R.S.E. Vol. ii. Pp. xiv + 500. (Cambridge: At the University Press, 1900.)

PROF. TAIT is to be congratulated on the energy with which this reprint is being pushed forward. The first volume, noticed in NATURE, vol. lx. p. 98, is already followed by a second, so that the completion of the work at an early date may be anticipated.

The present instalment contains two considerable experimental investigations; one of these, on the compressibility of water at very high pressures, was suggested by a previous research on the *Challenger* thermometers; for the second, on impact, we are indebted to the author's well-known interest in golf. There is also a very interesting discussion of the cause of the "soaring" flight of a golf ball.

The most important theoretical research consists of a revision of the kinetic theory of gases, from the old standpoint of elastic spheres. All students of this intricate subject will be glad to have Prof. Tait's acute examination of it in the present compact form. It is interesting to note, by the way, the author's frank confession: "I have . . . . abstained from reading the details of any investigation (be its author who he may) which seemed to me to be unnecessarily complex. Such a course has, inevitably, certain disadvantages, but its manifest advantages far outweigh them!" Let us hope that no indolent reader will be tempted to turn against Prof. Tait himself a *dictum* which conveys a very salutary warning to authors!

One of the most useful features of this reprint is the number of short papers which to many readers will now become known for the first time. There are also included a few biographical notices, as well as articles from the "Encyclopædia Britannica." In a note to the article on "quaternions" we are told that the sketch of the subject recently given by Prof. Klein in the "Theorie des Kreisels" rests on a misapprehension. This is one disappointment the more for those students who have vainly striven time after time to get a clear notion of what a quaternion really is, and who hoped that they had found at last something like a clear and compact and intelligible account of the matter. If, in spite of the fact that "the grandest characteristic of quaternions is their transparent intelligibility," men like Cayley and Klein are declared to have gone astray, one may be excused for asking whether there may not be something wanting after all in the official presentations of the subject?

The paper on the laws of motion hardly addresses itself to points on which a modern reader would seek enlightenment. Instead, we have verbal questions as to the meaning of "force" and the proper translation of certain phrases of Newton. Are not such questions disposed of once for all by the simple statement that since the time of Newton scientific people have specialised their usage of the word "force"? Although this has not been an unmixed advantage, it is probably now irrevocable. Still, one may reasonably urge that it is hardly fair to take a popular term, used in a great variety of senses, to attribute it for special purposes one and only one of these, and then to denounce as ignorant any one who continues to use it in its former latitude. The scorn, for example, which has been called forth by the term "centrifugal force" has often been most unjust, the physical notions of the users being clear enough, although they were not expressed in the conventional phraseology. The endless discussions which have been inflicted on us as to the meaning of the word "weight," furnish another instance of the trouble which may be wrought by specialists attempting to usurp functions which do not properly belong to them.

The last paper in the volume, on the teaching of natural philosophy, contains matter which probably hardly any one would question. Yet it well deserves reprinting, if only for the passage near the end which speaks of "the fatal objections to the school-teaching of physical science," based on the intrinsic difficulties of the subject, and the maturity of mind required to overcome them. Any one who is aware of the futility and the pedantry of a good deal that goes on in schools under the name of science-teaching will thank Prof. Tait for this courageous utterance. The mischief is that school-teaching is dominated by examinations, and that the kind of science-teaching which it is possible, and highly desirable, to have in schools does not readily lend itself to examination-tests of the ordinary kind.

The volume is marked by the same beauty and accuracy of printing as the former one. It is intimated that a third volume will complete the work.

HORACE LAMB.

WYATT'S BRITISH BIRDS.

British Birds; with some Notes in reference to their Plumage. By C. W. Wyatt. Coloured Illustrations. (London: William Wesley and Son, 1899.)

WHETHER the beautifully illustrated work on the same subject by the late Lord Lilford leaves room for the present volume and its predecessor, is a question for the publisher rather than for the reviewer to answer; but, if the stream of books on the subject be any criterion, the appetite of the British public for natural histories of the avifauna of their own country seems insatiable. Apart from all this, the present work, of which the first volume was issued in 1897, has high claims on the consideration of the public, the large size (4to.) of the paper on which they are printed permitting the plates to be on a scale of greater magnitude than in the work above-mentioned, while their excellence from an artistic point of view, as well as their apparent fidelity to nature, leaves little or nothing to be desired from the point of view of the connoisseur in animal painting. In too many instances we have either an inartistic but truthful portrait of the creature depicted, or an artistic picture in which details of coloration are sacrificed to the general effect; but in the present case, the happy mean appears to have been attained in these respects. The plates are signed with the initials "C. W. W.," but we are told in the preface that the colouring has been done by the daughters of Dr. Bowdler Sharpe, whose training is a sufficient guarantee for its accuracy.

It must, indeed, be understood that the book stands or falls by the plates, as the letterpress is restricted in the main to details concerning the plumage of the specimens figured, or to generalities relating to seasonal changes of colour, nothing in the way of description being given.

When the scientific names applied to the different species are those of almost universal acceptation, no references to other works are added; but in the case of those where uniformity is by no means general, a reference is made to the synonyms used in standard manuals, such as the fourth edition of "Yarrell." It may be added that the reference to the latter work in the case of the Hen-Harrier appears to have been introduced by mistake, as the nomenclature employed is the same. As regards generic nomenclature, the author adopts a middle course, avoiding the inordinate "splitting" followed by some ornithologists, as he does the excessive "lumping" favoured by others.

The first volume was devoted to the resident Passeres of the British Islands, and as the present commences with the migratory members of the same order, it will be evident that the author does not confine himself to a strictly systematic arrangement. In excluding the casual visitors, which, in our own opinion, have no right whatever to the title of British Birds, the author differs from the plan followed by some of his brother ornithologists, whose object seems to be to draw up as long a list as possible, without any regard to the facts of geographical distribution. The other groups included in this volume include the Picarians, Owls, Hawks, and Pigeons, so that the Game Birds, Waders, and Water-Birds alone remain for its successor.

As a handsome, and at the same time an accurate, series of volumes for the drawing-table, the work may be heartily commended to all bird-lovers with whom "money is no object."

R. L.

OUR BOOK SHELF.

Our Native [American] Birds, how to protect them, and attract them to our homes. By D. Lange. Pp. x + 162. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1899.)

LEST our readers should be misled into thinking that the present little volume is but another item in the already large literature of British ornithology, we have ventured to indicate its birth-place by a bracketed interpolation in the title.

The author, to whom the love of birds is evidently second nature, starts with the assertion that, with the exception of a few counties, the number of song-birds has of late years been steadily decreasing in the United States, and then proceeds to consider in detail—firstly, how this unfortunate state of things has been brought about, and, secondly, how it may best be remedied. Nor are song-birds alone considered, a certain amount of space being devoted to game-birds (inclusive of the *Anatidae*), many of which have likewise suffered severely.

The fact of the decrease in the former group seems to rest on conclusive evidence; the main causes assigned being lack of suitable nesting-places, want of water and food, the abundance of cats (domestic and feral), the ravages committed by boys, collectors, and plume-hunters, the aggressive habits of the English sparrow, and the use of poison in gardens and farms.

As regards legislative protection, the author wisely leaves this to the various "Audubon Societies," which have been established in the States, and other suitable agencies; devoting his attention mainly how to supply to his feathered friends such objects as are essential to their well-being, and how to guard them from the attacks of their chief foes. As our readers are aware, many towns and villages in the States are located on the open prairie, where the absence of cover renders the birds especially liable to destruction; while even in districts more favoured by nature there seems to be a great tendency to make the gardens of residents as open and bare of shrubbery as possible. Old hollow trees, too, which form the nesting-places of so many species, have likewise been ruthlessly felled, so that the unhappy birds have literally no retreats wherein to hide.

Accordingly, the planting of trees, vines and shrubs (especially kinds which afford good cover and edible berries) is strongly urged, while beds of suitable kinds of flowers, such as gladioli, should be planted to attract humming-birds. For species building in hollow trees, nesting-boxes should be provided in suitable sites; while drinking and bathing vessels should be furnished in the dry season, and abundance of suitable food at all times. The noxious sparrow is to be hustled out of the usurped nesting-places, while coils of barbed wire, or suitable wire fences, must be used to balk prowling cats. As to the best means of dealing with the human foes of birds, these, as already said, are mainly left to the powers that be; but the formation of "bird-leagues," by members of the female sex who are willing to forego the ornamentation of their head-gear by the plumes of songsters, is strongly urged, as is the repression of the ordinary collector. Education, and the establishment of an annual "bird-day," are also regarded as important factors in the scheme.

The author has performed his task in a manner calculated to interest his readers, and his work should be acceptable to those on both sides of the Atlantic who love to hear bird-music around their homes. R. L.

Der Ursprung der Kultur. Von L. Frobenius. Bd. i. Der Ursprung der Afrikanischen Kulturen. Mit 26 Karten, 9 Tafeln, sowie ca. 240 Text illustrationen. Pp. xxxi + 368. (Berlin: Gebrüder Borntraeger, 1898.)

THIS is the first volume of an ambitious work. The author proposes to seek out the Origin of Civilisation on what he considers to be a new plan. But in reality Mr. Frobenius can only work on the old lines; he can only compare one custom with another, and use the same old weak argument from analogy to prove connection between tribes who have similar customs: "er lehrt alte Weisheit als neue." ("Programm": p. xii.). He proclaims the virtues of his "new plan," however, in the very manner of the Teutonic *Gelehrte*: he considers himself to be laying the foundations of a new science (p. xiv.): "Was bedeuten alle Entbehrung und Entsagung, wenn sie auch noch so herb sein mögen, gegenüber dem grossen Glücke, schaffend und Schöpferisch bei der Gründung einer Wissenschaft teilnehmen zu können. Ich habe die bitteren Stunden und herben Übel nie so stark empfunden, wie die Freude über die Erfolge, *das stolze Gefühl des selbstständigen Schöpfers.* Und ich habe den herzlichen Wunsch, dass etwas von jener Spannkraft, die Müdigkeit und alle sonst vielleicht verzeihlichen und berechtigten Wünsche vergessen lässt, aus diesen Blättern dem Leser bemerkbar werden und in ihn übergehen möge." The italics are our own: we greatly fear that Mr. Frobenius, like so many of his "Fachgenossen," has no sense of humour. He does not forget to castigate his predecessors in ethnological study, some of whom are apparently prone to set fool's caps on their heads and give them out to be academical costume (p. ix.). The whole "Programm" which precedes the book is a typical product of what the author himself calls the "überhitzten Gelehrtenkopf" (p. ix.).

Apart from the rather ridiculous pretensions of its introduction, the book as a whole is useful enough as a series of essays on various phases of African ethnology, which are often very interesting, *e.g.* the chapter on building-styles (p. 194 ff.). They cannot, however, be said to prove much with regard to the origin of African civilisation, which is presumably what they are intended to do. The author's arguments in favour of his theory of the "Malayonigritish" origin of West African culture are interestingly put forward.

Absolutely nothing whatever is said about *Ancient* Africa: not a word with regard to the Zimbabye ruins, which we had expected to find exhaustively discussed here: not a word about the wonderful civilisation of Egypt, with the earliest beginnings of which we have now, thanks to the energy of Prof. Petrie and Messrs. Quibell, De Morgan and Amélineau, been brought into close contact, and which appears more and more African in character the further we go back. Not a single comparison of the Zulu and Egyptian head-rests even, to take the instance which first comes to mind; but a curious misapprehension on p. 97, where Fig. 60 is described as a "Sceptermesser der Pharaonen," whatever that may be: the object in question is merely the well-known and commonly-used Egyptian sword called *Khepesh* (on account of its resemblance to the shape of an animal's *thigh*, e.g. *khepesh*), which had nothing in particular to do with either Pharaohs or sceptres.

Of the illustrations, while the majority are good, some are certainly very bad, *e.g.* Plate iv. and Figs. 137, 139.

The Amateur's Practical Garden Book. ("The Garden Craft Series.") By C. E. Hunn and L. H. Bailey. Pp. vi + 250. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1900.)

THE sub-title of this book very aptly indicates the nature of its contents, "The simplest directions for the growing of the commonest things about the house and garden."

The subjects dealt with are arranged alphabetically, beginning with Abobra and ending with Zinnia. It must not, however, be concluded that the book is merely a dictionary of plant names. It is much more.

Thus, under the heading "Annuals," we have an explanation of the term, the cultural details necessary for their proper growth, together with lists classified according to the colour of the flower, or the purpose the flowers have to serve.

The book is written for the climate of New York, but with the requisite modifications it is suitable for gardeners in this country also. It is severely practical, and principles, though perceptibly diffused, are not so much as mentioned.

Man and his Ancestor: a Study in Evolution. By Charles Morris. Pp. 238. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.)

THE author has written this little book for the purpose of providing the intelligent person with a good and sufficient reason for the evolutionary faith that is in him. It is true that there is no book of a non-technical nature that quite covers the ground taken by the author, and it is only fair to him to state that he has filled this gap in a most creditable manner. It is obvious that many stages in the evolutionary history of man can only be guessed at by us, and that there is much room for discussion in these hypotheses as well as in the interpretation of accepted facts; but Mr. Morris is not aggressively dogmatic, nor has he striven to be sensational. There are, however, several statements to which exception can be taken in the chapter on the "Vestiges of Man's Ancestry." If Mr. Morris thinks the function of the thyroid is a "minor and obscure one," let him have his own excised and then he will know. Club foot is not generally regarded as a reversion to the anthropoid foot. Taking it all round, the book may be safely recommended to that class of readers for whom it was intended, and it may lead such to consult the recognised works on the various topics on which he touches. Owing to no references being given, inquirers will have to seek elsewhere for an introduction to the literature of human evolution. The author has not considered his little book worthy of an index.

A First Geometry Book. By J. G. Hamilton and F. Kettle. Pp. ii + 91. (London: Edward Arnold, 1900.)

THIS little book contains a series of elementary exercises in geometry based on the method of allowing the pupil to deduce as many principles as possible after, and from the results of, experiments or exercises dependent on them. The deductions are drawn from the pupil's own measurements of his drawings to scale of the usual geometrical figures. From this it will be understood that the book really consists of a series of graduated exercises which appear to be well chosen and arranged, and likely to prove suggestive to teachers and useful to students beginning their first studies of the subject.

LETTERS TO THE EDITOR.

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

A Third Specimen of the Extinct "Dromaius ater," Vieillot; found in the R. Zoological Museum, Florence.

IN January 1803, a French scientific expedition, under Baudin, visited the coast of South Australia and explored Kangaroo Island, called by them "Isle Decrès." One of the naturalists attached to the expedition was the well-known F. Péron, who wrote an interesting narrative thereof. He noticed that Decrès Island was uninhabited by man, but, although poor in water, was rich in kangaroos and emus (*Casoars* he calls the latter), which in troops came down to the shore at sunset to drink sea-water. *Three* of these emus were caught alive, and safely reached Paris; we learn from the "Archives du Muséum" that one was placed in the Jardin des Plantes, and two were sent to "La Malmaison," then the residence of the Empress Josephine. We learn later that two of these birds lived to 1822, when one was mounted entire and placed in the ornithological galleries of the "Muséum," the other was prepared as a skeleton and placed in the comparative anatomy collections. No mention is made of the ultimate fate of the third specimen.

Péron was unaware that the emu he had found on the Kangaroo Island was peculiar and specifically quite distinct from the New Holland bird; this was found out much later, and *too late*; for after Péron and his colleagues no naturalist evermore set eyes on the pigmy emu of Kangaroo Island in its wild condition! It appears that when South Australia was first colonised, a settler squatted on Kangaroo Island and systematically exterminated the small emu and the kangaroos. When the interesting fact was ascertained that Péron's emu was a very distinct species quite peculiar to Kangaroo Island and found nowhere else, *Dromaius ater* had ceased to exist; and the only known specimens preserved in *any* museum were the *two* mentioned above, in Paris.

For some years past my attention had been drawn to a small skeleton of a Ratitæ in the old didactic collection of the R. Zoological Museum under my direction; it was labelled "Casoario," but was in many ways different from a cassowary; but other work kept me from the proposed closer investigation, and it was only quite recently, during a visit of the Hon. Walter Rothschild, on his telling me that he was working out the cassowaries, that I remembered the enigmatical skeleton. A better inspection showed us that it is, without the least doubt, a specimen of the lost *Dromaius ater*. I afterwards ascertained that it had been first catalogued in this museum in 1833; that most of the bones bore written on them in a bold round hand, very characteristic of the first quarter of the nineteenth century, the words "Casoar mâle;" and lastly, that during the latter part of Cuvier's life, about 1825–30, an exchange of specimens had taken place between the Paris and the Florence Museums. I have thus very little doubt that our specimen is the missing *third* one brought alive to Paris by Péron in 1804–5.

This highly interesting ornithological relic is now on loan at the Tring Museum, and can be seen there by any ornithologist in England who may wish to examine it. I intend shortly to give a fuller notice of this valuable specimen.

HENRY H. GIGLIOLI.

R. Zoological Museum, Florence, May 15.

Chlorophyll a Sensitiser.

IT was with a feeling of great satisfaction that I read the concluding lines of Dr. H. Brown's highly interesting presidential address (NATURE, September 14, 1899). I was glad to see that this distinguished chemist, to whom the physiology of plants is so much indebted, adopts certain views on the chlorophyll function, which I have been defending for more than a quarter of a century against the leading authorities of the German Physiological School (Sachs and Pfeffer). But since some slight errors seem to have crept into Dr. Brown's statements of my opinions on the subject, I may, perhaps, be allowed to bring forward the following corrections.

Dr. Brown seems to believe that the analogy between the action of chlorophyll and that of a chromatic sensitiser was "first pointed out by Captain Abney" and "more fully elaborated" by me; and secondly, that I give "a far too simple explanation of the facts" by admitting a "*mere physical* transference of vibrations of the right period from the absorbing chlorophyll to the reacting carbon dioxide and water."

To begin with the less important question of priority, I must confess that up to this date I am not aware of Captain Abney's claims. Had I known them, I should have been the first to acknowledge my debt to that accomplished investigator, whose brilliant achievements in this line of research I have never omitted to admire. The fact that the dissociation of the carbon dioxide in the green leaf is affected by the rays of light absorbed by chlorophyll was for the first time established by my researches in 1873, and an account of these experiments presented to the International Congress of Botany in Florence (May 1874).[1] At the same date (1873) Prof. H. Vogel made his important discovery of the chromatic sensitisers, and in November 1875, E. Becquerel applied it to the chlorophyll-collodion plates. In May 1875 appeared my Russian work on the chlorophyll function, of which the French article[2] in the *Annales de Chimie et de Physique* of 1875, as expressly stated, is but an extract. In this French translation the idea that chlorophyll may be considered as a sensitiser is fully discussed. Consequently any claim of priority may be fairly advanced, only in favour of a paper having appeared in the short interval of a year—from May 1874, when I *announced the fact*, to May 1875, when I *interpreted it* in the light of H. Vogel's recent discovery. On consulting the *R. S. Catalogue of Scientific Papers*, I could not find any paper of Captain Abney's for this period 1874–1875.[3]

So far concerning the priority question. Passing to the second point, I am sorry to say Dr. Brown is decidedly in the wrong, for in my French paper just cited, and which probably escaped his notice, after discussing the quite recent discoveries of H. Vogel and Edmond Becquerel, I conclude: "Ou ne saurait pour le moment décider la question de savoir si cet effet serait dû uniquement à un phénomène physique, ou bien si la matière colorante prendrait part à la transformation chimique. Cette dernière manière de voir ferait rentrer l'action de cette matière (chlorophylle) dans la règle générale de l'action accélératrice des matières organiques dans les réactions photochimiques, car c'est généralement en absorbant les produits de la dissociation, effectué par la lumière, que les substances organiques détruisent cet equilibre qui tend à s'établir entre le corps décomposé et les produits de décomposition et c'est ainsi qu'une dissociation partielle aboutit à une décomposition complaite."[4] At a later date, in a report presented to the International Congress of Botany in St. Petersburg (1884), taking to account the subsequent photographical work on the sensitisers, I brought forward experimental proof that chlorophyll may be considered a sensitiser in Captain Abney's sense of the word: "La chlorophylle est un sensibilisateur régénéré à mesure qu'il se décompose et qui provoque en éprouvant une décomposition partielle la décomposition de l'acide carbonique."[5]

From all these quotations it may be inferred that I always kept in view the chemical aspect of the chlorophyll function, now advocated with such stress by Dr. Brown.[6]

But I did not content myself with such purely theoretical considerations, and ever since have been in search of what Dr.

[1] *Atti del Congresso Botanico tenuto in Firenze*, 1875, p. 108. At a still earlier date (*Botanische Zeitung*, 1869, No. 14), I found out the source of T. W. Draper's error, and proved that the process is chiefly due to the red rays of light.

[2] "Recherches sur la décomposition de l'acide carbonique dans le spectre solaire par les parties vertes des végétaux" (Extrait d'un ouvrage "Sur l'assimilation de la lumière par les végétaux," St. Petersbourg, 1875, publié en langue Russe) *Annales de Chimie et de Physique*, 5 serie, t. xii. 1877.

[3] Prof. Pfeffer, in his account of the whole subject ("Pflanzenphysiologie." Zweite Auflage, pp. 325-341), goes so far as to attribute this sensitiser theory of the chlorophyll function to Prof. Reinke, whose paper appeared ten years later.

[4] *L.c.* p. 40. In a footnote I add that certain physiological facts seem to agree with this point of view.

[5] "État actuel de nos connaissances sur la fonction chlorophyllienne" (*Annales des Sciences Naturelles Botanique*, 1885, p. 119).

[6] At a still earlier date (in a Russian work on the "Spectrum Analysis of Chlorophyll," St. Petersburg, 1871) I even expressed Dr. Brown's present point of view in the form of an equation:

$$\begin{aligned} XO + CO_2 &= XCO + O_2 \\ &\quad + H_2O \\ &= XO + CH_2O + O_2 \end{aligned}$$

X being Dr. Brown's hypothetical "reduced constituent of chlorophyll."

Brown so appropriately terms the "reduced constituent of chlorophyll." My persistent endeavours resulted in the discovery of *protophylline*, a substance obtainable through the action of nascent hydrogen on chlorophyll solutions.[1] Some years later I discovered this substance in the living plant.[2]

The existence of a *reduced constituent of chlorophyll* may be consequently considered as a perfectly established fact, and will be probably brought to account by the chemical theory of the chlorophyll function. I conclude my French paper with the following words :—" L'étude de ces substances ne manquera pas à jetter une vive lumière sur le *coté chimique* de la fonction chlorophillienne *qui a été étudié dans ce dernier temps presque exclusivement au point de vue physique*."

To sum up: though it may be clearly seen that for nearly thirty years I have been considering chlorophyll as a *chemical* sensitiser (or, strictly speaking, an *absorbent* of the products of dissociation of CO_2 and H_2O), still even now I must confess that this theory lacks direct experimental proof and may be considered only as a matter for further research, whereas the physical aspect of the question (*i.e.* that CO_2 and H_2O are decomposed through the agency of those rays of the spectrum, which are absorbed and somehow transformed by chlorophyll) is but the expression of a fact, put beyond any doubt by my researches, both on the decomposition of CO_2 and on the production of starch in the living plant.[3] But I do not abandon the hope that the discovery of the *protophylline* may turn out some day to be a step in the direction of a *chemical theory* of the chlorophyll function, somewhat similar to that of the colouring matter of the blood—an analogy which has been present to my mind ever since I became acquainted with the classical researches of Sir G. G. Stokes in that direction.

University, Moscow. CLEMENT TIMIRIAZEFF.

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I REGRET that M. Timiriazeff should regard the concluding lines of my presidential address as doing him some injustice.

No one can be more impressed than I have been with the extreme beauty and importance of M. Timiriazeff's work, which cleared away many illusions, and for the first time prominently brought out the fact that the rays corresponding to the principal absorption band of the chlorophyll spectrum are those which are mainly active in the assimilatory process.

I have always regarded M. Timiriazeff's paper of 1885 (*Ann. des Sciences Nat.* [*Bot.*], vol. ii. p. 99) as being one of the most convincing and eloquent expositions in scientific literature, and the final proof of the proposition there laid down was given by the author in 1890 (*Compt. rend.* 110, 1346), when he succeeded in showing that the reappearance of starch in a depleted leaf exposed to a pure spectrum only takes place in the region of the red corresponding exactly to the principal absorption band of chlorophyll.

With regard to the first point raised in M. Timiriazeff's letter, I may say that when preparing my address I experienced a difficulty in ascertaining who it was that first drew attention to the existing analogy between chlorophyll and a chromatic sensitiser.

There is no complete list of Sir William Abney's papers, and knowing that he has sent many communications on this and cognate subjects to photographic journals in various parts of the world, I applied to Sir William Abney before writing what I did. There can be no doubt that chromatic sensitisers were very much "in the air" immediately after Vogel's discoveries of 1873, and it is probable that the application of these new ideas to chlorophyll occurred independently to Abney, Timiriazeff and Becquerel.

M. Timiriazeff's second objection is that I have not sufficiently taken into account his views of the function of chlorophyll as a *chemical sensitiser*. On this point I may say that I had in view his paper of 1885: "État actuel de nos connaissances sur la fonction chlorophyllienne," which it was fair to imagine fully embodied the author's view up to that date. It is certainly the *physical rôle* of chlorophyll which is there insisted upon, as the following quotation indicates: "Le rôle de la chlorophylle dans le phénomène de la décomposition de l'acide carbonique peut donc être résumé ainsi : elle absorbe les radiations qui possèdent la plus grande énergie et transmet cette énergie aux molécules de l'acide carbonique qui, à elles seules, n'éprouveraient pas de décomposition, étant transparentes pour ces radiations énergiques."

That the physical conception was certainly uppermost in M. Timiriazeff's mind at that time is further shown by the diagram and remarks immediately following, in which he regards the molecules of carbon dioxide as suffering "shipwreck" in the luminous undulations corresponding to maximum amplitude.

It is, however, quite clear from M. Timiriazeff's references to his paper of 1877, and especially to his Russian paper of 1871, neither of which I have seen, that he has expressed views which are practically identical with those contained in the concluding remarks of my address. It is to be regretted that these ideas were not again clearly brought forward in the 1885 paper, which purported to give the author's latest views on the whole question, and that the physical idea of the immediate transference of the energy of radiation was there made the dominant one.

52, Nevern Square, Kensington. HORACE T. BROWN.

[1] The first description of this curious substance was given in two short notes communicated to these columns: "Colourless Chlorophyll" (NATURE, 1885, p. 342) and "Chlorophyll" (NATURE, 1886, p. 52). For more ample details, see *Comptes rendus*, 1889.

[2] "La protophylline dans la plante vivante" (*Comptes rendus*, 1889).

[3] "Enregistrement photographique de la fonction chlorophyllienne par la plante vivante" (*Comptes rendus*, 1884).

A Simple Experiment on Thermal Radiation.

THE following experiment, which has been successfully performed by our students for several years, may be of interest to teachers of physics.

Three chemical thermometers are chosen of equal size and shape. The bulb of one is silvered, of the other covered with dead black paint by dipping it into a mixture of lamp-black and alcohol, whilst the third is left unchanged. For silvering, any of the well-known solutions and processes will be applicable. The thermometers indicate the same temperature if there is no source of radiation near them.

But if a gas flame, for example, an Argand burner, be placed at a distance of 20 centimetres from them, so that the thermometers, hanging from a stand, are at equal distances from the flame, the temperature rises at a different rate, and to a different, though in each thermometer constant, height. The silvered

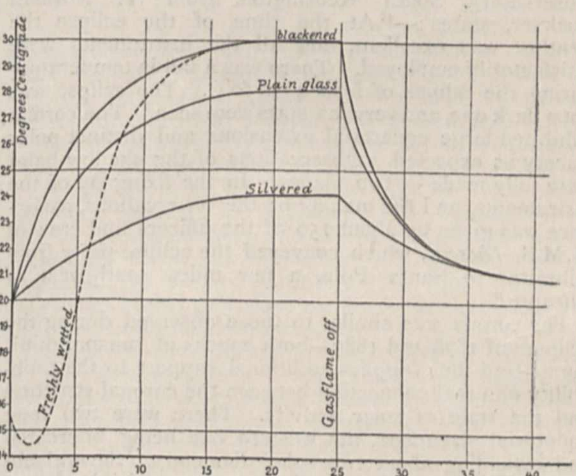


FIG. 1.

thermometer gives the lowest reading, and the blackened the highest, whilst the thread of the uncovered one stops at some point between these readings nearer to that of the blackened than the silvered; for the different surfaces of the thermometers absorb the radiation of heat generated in the flame in different proportion. The blackened thermometer bulb almost completely absorbs the rays falling on it; the silvered and polished bulb reflects the radiation reaching it; the plain glass bulb partly reflects and partly absorbs the rays. Thus, none but the silvered bulb thermometer indicates the temperature of the air communicating heat to it by conduction. As the other thermometers rise in temperature, they emit radiation; and when the amount of heat emitted from them equals the amount received through radiation from the gas flame, they are in the final stationary state, which is, of course, reached by the thermometers at different temperatures.

If the gas flame is put out, the temperatures of the three thermometers fall at different rates. Observations made simultaneously on them every minute, and plotted on squared paper, illustrate fairly well Kirchhoff's law enunciating that a body emits those rays best which it absorbs best. When the gas flame is replaced by a freezing mixture, the greatest fall of temperature is experienced by the blackened thermometer, and the least by the silvered one, for the same reasons.

The same arrangement of thermometers may be used to show the cold produced by evaporation. For this purpose, the bulb to be blackened has to be wetted immediately before starting the radiation experiment. First the temperature of this thermometer falls, even though the gas flame be lighted, but after a few minutes its temperature rises very quickly to reach the same state of equilibrium as when taken with dry black paint. In Fig. 1 the dotted curve represents the behaviour of the freshly wetted blackened thermometer.

For silvering the thermometer bulbs, we use most successfully the process described first by A. Martin in *Poggendorff's Annalen* (cxx. 1863, p. 335), and reprinted in many of the books on practical physics. K. T. FISCHER.

München (Bavaria), Kgl. Technische Hochschule.

THE TOTAL ECLIPSE OF THE SUN.

THE last total solar eclipse of this century appears to have been successfully observed all along the line of totality. The weather conditions were favourable at all the observing stations, and numerous photographic and visual observations have been made of the phenomena revealed during a total eclipse. Elaborate arrangements were made to study the eclipse in all its aspects, and it has fortunately been possible to carry them out in a most satisfactory manner.

A code telegram received at the Solar Physics Observatory, South Kensington, from Sir Norman Lockyer, states:—"At the time of the eclipse the weather was excellent, and all the instruments were satisfactorily employed. There was a fall in temperature during the eclipse of from 4° to 6° C. The eclipse was not a dark one, and very few stars were seen. The corona exhibited large equatorial extensions and distinct polar tracery as expected. Observations of the shadow band were fully made in two planes. In the fixing up of the instruments, and the making of the observations, assistance was given by about 150 of the officers and crew of H.M.S. *Theseus*, which conveyed the eclipse party from Gibraltar to Santa Pola, a few miles south-west of Alicante."

The corona was similar to those observed during the eclipses of 1878 and 1889—both epochs of sunspot minimum—and thus supplies additional support to the probability of a real connection between the coronal structure and the state of solar activity. There were two long equatorial streamers, the western one being bifurcated and extending about two solar diameters. Several observers note that the inner corona was visible for at least *five* seconds after totality.

The eclipse was a short, and therefore a bright, one, which accounts for the general report that no shadow was seen either on land or in the atmosphere, and that very few stars were visible. Mercury and Venus were, however, observed. All the reports agree in estimating the duration of totality as shorter than was expected, so that the lunar tables will need slight revision for future computations.

Important observations were made of the shadow bands, which are stated to be very different in many respects from those previously observed. From one of the American stations it is reported that the bands were about one inch in breadth, their general direction being south 56½° E.; before totality their motion was at right angles to this—that is, almost north-east; and in the opposite direction after totality. Superposed on the linear bands, however, were certain dark patches previously unnoticed, having a motion at right angles to that of the bands. Baily's beads were well seen at the instants of second and third contact.

Prof. Todd, at Tripoli, is reported to have successfully employed twenty photographic cameras, one of which was furnished with a lens of 24 inches aperture.

The party at Pinehurst, from the U.S. Naval Observatory, under Prof. Skinner, obtained a good series of spectrum photographs, including five with plane and concave gratings and four with an objective prism; also five large scale photographs of the corona with a lens of forty feet focus..

Prof. Pickering obtained a good series of photographs with the new large instrument he had specially made for searching for an intra-Mercurial planet.

As we go to press, the following description of the observing parties at Santa Pola has been received from Sir Norman Lockyer.

PREPARATIONS AT SANTA POLA.

Santa Pola, Friday, May 25.

The party from the Solar Physics Observatory arrived here on May 17, and now, thanks to the assistance so freely rendered by the Spanish authorities of all grades, and the strong working parties furnished by H.M.S. *Theseus*, the instruments are all in order and we are ready for the eclipse.

At Gibraltar the Captain of the *Theseus* sent off Mr. Daniels, torpedo gunner, to meet the Expedition, and the sixty-nine cases of instruments were carefully transferred to a lighter, and so soon as they were landed here those belonging to each instrument were at once brought alongside the piers which had already been erected for them on a site as near the landing stage as possible, thanks to the diligence of Mr. Howard Payn, a volunteer assistant who had preceded the party by rail and had secured the necessary bricks at Alicante.

The prismatic cameras, and those of the ordinary kind, fed by cœlostats and siderostats, with all prisms and mirrors, were in adjustment by the 21st, and drills were begun on the 22nd.

The parties of observers are as follows; and careful notes of the arrangements made are being kept, as some improvements have been made on those adopted in 1898.

Parties on Shore.—Prismatic cameras. (1) One prism (20 ft.); (2) two prisms (7 ft. 6 in.). Coronagraphs. (3) Graham (f. 6·5); (4) Dallmeyer (f. 8·0 about); (5) De la Rue (f. 17·5); (6) long focus (f. 48). (7) Discs. (8) Shadow bands. (9) Meteorology. (10) Stars. (11) Landscape colours.

Parties on Board.—(1) Stars. (2) Shadow. (3) Meteorology. (4) Landscape.

The whole party is in robust health, thanks to the glorious climate and any amount of work in the open air. We live in a little inn, which since the Queen's birthday has blossomed into the "Victoria Hotel," kept by one Frasquito Dols, a Spanish sailor and sea-cook, a regular "handy man," who has put up mosquito curtains, and rigged up a lift to carry our well-cooked food and excellent local wine to the first floor where we reside; in rooms which, though furnished with unparalleled simplicity, are absolutely clean. It seems a pity that more do not know of this delightful climate so near home, in which the winter months may be so pleasantly spent in the shadow of date palms.

The ship is much further away from the shore than in 1898—some 2000 yards—and the winds rise very suddenly in the open roadstead. The administration of the camp, therefore, devolves upon Lieut. Doughty, R.N., who, with Lieuts. Andrews and Patrick, remain constantly on shore in a pile-dwelling—a bathing establishment which has seen better days, and has been rechristened "Theseus Villa."

The "Scotch Commission," as it is called here—that is, Dr. Copeland's party—has chosen a site up the hill behind the town some distance from the jetty.

Elaborate arrangements have been made for the observation of shadow bands, two walls, E. and W. and N. and S., composed of first-class volley targets 16 × 6 ft., having been erected on a level space which has been whitewashed.

Six discs have been set up on spars, and most careful drills have taken place. I have been quite astonished at the exact reproduction of all the features of a dummy corona set up on each occasion.

It appears that the east wind is the best for us, and it is blowing now; a cloudy morning generally is followed by a cloudless sky in the afternoon. The weather chances are good, but they are not perfect.

NORMAN LOCKYER.

FIFTY YEARS OF GEOLOGICAL SURVEY IN INDIA.

THOUGH the Honourable East India Company had showed their interest in the advancement of geological science by the appointment, so long ago as 1818, of a geologist to the Great Trigonometrical Survey, it is but fifty years since the first "Report of the Geological Survey of India for 1848-49," by Dr. John McClelland, was published. In 1851 Dr. McClelland was relieved by Dr. Thos. Oldham, who, on his arrival in Calcutta, found the Geological Survey represented in the capital of India by a room, a box and a messenger. One assistant, Mr. W. Theobald, was already in the employment of the Company, and during the following five years seven assistants were appointed, of whom but Mr. H. B. Medlicott and Dr. W. T. Blanford, names cut deep in the record of Indian geology, survive.

It was not, however, till 1856 that the Geological Survey was established as a regularly organised service, with a sanctioned establishment of superintendent (now styled director), fifteen graded assistants and a palæontologist. In spite of the increased area over which British rule extends, the establishment sanctioned in 1856 remained the same, with some minor, temporary changes, and an alteration of nomenclature, till 1892, when, instead of an increase, the permanent staff was reduced by three, and to compensate for this reduction arrangements were made for the employment of two "specialists" for terms of years, who were expected to devote their services more especially to economic geology. From one cause and another, this scheme has not received a full trial yet, and it is only during the present year that the full sanctioned staff is at work. The experiments so far made in the temporary employment of assistance to the Geological Survey, for the special purpose of economic work, cannot be regarded as successful, and the result of the present trial will be watched with interest, as it is likely to have great influence in the shaping of the future course and policy of the Survey.

The concrete results of less than half a century's work with this inadequate staff are a geological map of nearly the whole of India proper, which is accurate as regards its main features for this large area, and as regards details for a large proportion of it; and a considerable acquaintance, largely accompanied by maps, with the mountainous country to the north-west and north, and of the countries to the east, which are included in the Indian Empire. The published results are contained in thirty volumes of the "Records," twenty-nine of the "Memoirs," and twenty volumes, not counting those only partly published, of the "Palæontologia Indica."

Besides this collection of separate memoirs there was prepared, with the approval and sanction of the Government of India, a "Manual of the Geology of India," in two volumes, by Messrs. H. B. Medlicott and W. T. Blanford, published in 1879, to which were subsequently added a volume on the "Economic Geology," by the late Dr. Valentine Ball, and one on the "Mineralogy," by Mr. F. R. Mallet. These volumes contained not only much information collected by the Survey, which it had not been possible to publish previously, but for the first time, by collecting scattered information into one general review, made the geology of India generally accessible and intelligible. The need for, and value of, these volumes is shown by the fact that they soon went out of print, and in 1894 a revised version of the first two volumes was issued. The progress of the Survey in the period intervening between these two issues had been so great that a totally different scheme could be adopted, and instead of the series of separate descriptions of isolated areas, which was to a large extent inevitable in 1879, it was possible to treat the geology of India as an harmonious whole in 1894. A re-issue of the third volume of the original edition, the volume on "Economic Geology," has also been commenced, but though nominally a re-issue, it is, even more than in the case of the stratigraphical and structural geology, a new book, being different in scope and in aims, and containing no part of the original work.

The results of the Geological Survey, apart from its publications, are to be looked for both in India and out of it. In India, in the economic development of the Empire; and out of India, in the influence they have had on the advancement of geological science. The former of these is naturally that to which the Administration attaches the greater importance, and in this connection the existence of the Survey is amply justified in the fact that two of the coal-fields, which yield an important part of the coal-supply of India, were discovered and explored by the Geological Survey. Singarenni, surveyed by Dr. W. King, and Umaria, by Mr. T. W. Hughes, have, from their geographical position, a much greater importance than would appear merely from a numerical statement of the number of tons of coal raised in them, for they serve to supply a large area with cheap fuel which would otherwise be deprived of that advantage. These two fields in themselves would justify the existence of the Survey, from an economic point of view, apart from other benefits; but besides this the existence of a band of trained advisers, and of the observations accumulated by them, has frequently been instrumental in preventing the useless expenditure of large sums of money, and in this way alone the Survey has rendered an ample return for its maintenance.

Though the Administration is naturally most interested in the economic aspects of the work of the Geological Survey, there has never been any attempt to convert it into a mere prospecting or mining department. The Government of India has always recognised purely scientific work as an important duty of the Survey, and regarded the advancement of science not only as a thing to be desired and encouraged on its own account, but as furthering and rendering more valuable the economic results of the Survey, by improving the instrument with which it works. It is this portion of the work of the Survey which is of the greater interest outside India, and more especially to the readers of NATURE.

First among the results which have influenced the course of geological science may be placed the recognition of the importance of deposits formed on land, in which Indian survey took an early and important part. It was shown that the Gangetic alluvium, formerly looked upon as a marine deposit, was, as regards its upper layers at least, a land deposit; it was shown that the great series of sandstones and conglomerates of which the foot-hills of the Himalayas are composed were formed, not in the sea, but on land, by rivers which were the ancestors of those now draining the Himalayas; the great Gondwana system was shown to be exclusively a dry land deposit, and later the same origin was attributed to the great Vindhyan system.

In the next place we have the recognition of the Permian glacial epoch. The first description of these beds was published in the *Memoirs* of the Geological Survey in 1856, and their glacial origin proclaimed in 1875 by the late Mr. H. F. Blanford. Though the idea of glaciation in Permian times and in what are now low latitudes has met with great opposition, it has gradually made progress, and it is now generally recognised that the Permian boulder-beds of India, though extending into regions that are now within the tropics, are relics of a bygone glacial epoch. In Africa, the glacial origin of similar beds has been accepted by more than one observer; and in Australia—where the traces of glacial action in the marine Permian or Permo-Carboniferous beds, below the principal coal-measures, was first recognised by a member of the Indian Geological Survey who had been deputed by the Indian Government to study the Australian coal-measures—the existence of glacial action on a large scale has been fully confirmed by workers in that country. In South America, too, it seems that there are similar beds, of apparently the same age, and the evidence of this widespread glacial epoch, more remarkable in many ways even than the post-Tertiary extension of glaciation, must be reckoned with in any speculations attempting to account for the great climatic changes of which the past sediments bear witness.

The labours of the Indian Geological Survey have had important results in geological science in other minor points, too numerous to detail in the limited space of an article, but a mention of the great earthquake of 1897 cannot be omitted. This earthquake was the greatest of which there is historic record, exceeding the great Lisbon earthquake of 1755; but even before this was known the Indian Government had ordered the Survey to make a complete scientific investigation of it. Being the greatest earthquake of which there is historic record, the visible effects were on an unprecedented scale, and its investigation has consequently yielded results which must be taken into account in all future seismological research. Nor must mention be omitted of one of the most recent suggestions, which appears likely to be fruitful of results, made in 1898 by Mr. T. H. Holland, that much of the decomposition, and more especially hydration, of the minerals composing igneous rocks was submarine, and that the undecomposed state of similar rocks, even of perishable minerals like olivine and nepheline, in certain regions, is due to these being ancient land-areas which have not been submerged beneath the sea since a remote geological period.

Such, briefly stated, is the record of the Geological Survey of India, a record which reflects credit on all who have been concerned in the making of it. Yet it must not be forgotten that credit is due also to the Civil Administration of India, which has not only maintained the staff by whom the record has been made, but has given the further pecuniary assistance, modest in amount but steadily continued, which has enabled the Survey to form a museum fully illustrating the geology of India in all its branches, to establish a well-equipped laboratory, and to collect a library which, as a geological working library, is probably unsurpassed by any and equalled by few.

NOTES.

M. DARBOUX, Dean of the Faculty of Sciences of Paris, has been elected permanent secretary of the Paris Academy of Sciences, in succession to the late M. Joseph Bertrand. Prof. J. Willard Gibbs, professor of mathematical physics in Yale University, has been elected a correspondant of the Academy in the section of mechanics. Prof. J. Chatin, assistant professor of histology at the Sorbonne, has been elected a member of the section of anatomy of the Academy, in succession to the late M. Blanchard.

THE recommendations of the international conference which recently met in London to determine the steps which might usefully be taken for the preservation of wild animals, birds and fish in South Africa, have now been published as a Parliamentary Paper. The zone within which it is proposed to apply the provisions of the Convention is bounded on the north by the 20th parallel of north latitude, on the west by the Atlantic Ocean, on the east by the Red Sea and by the Indian Ocean, on the south by a line following the northern boundary of the German possessions in South-Western Africa, from its western extremity to its junction with the River Zambesi, and thence running along the right bank of that river as far as the Indian Ocean. To preserve the various forms of animal life existing in a wild state within this zone, it is proposed to prohibit the hunting and destruction of certain animals, especially females when accompanied by their young or capable of being otherwise recognised, of which the protection, whether owing to their usefulness or to their rarity and threatened extermination, may be considered necessary by each local government. The establishment, as far as it is possible, of reserves within which it shall be unlawful to hunt, capture or kill any bird or other wild animal except those specially exempted from protection by the local authorities, is recommended, and also of close seasons with a view to facilitate the rearing of young. It is proposed to put export duties on the hides and skins of giraffes, antelopes, zebras, rhinoceroses and hippopotami, on rhinoceroses and antelope horns, and on hippopotamus tusks, and to prohibit the hunting or killing of young elephants. Measures are to be taken for ensuring the protection of the eggs of ostriches, and for the destruction of the eggs of crocodiles, of those of poisonous snakes, and of those of pythons. It is, however, understood that some of the principles laid down may be relaxed, either in order to permit the collection of specimens for museums or zoological gardens, or for any other scientific purpose.

PROF. J. PERRY, F.R.S., has been elected president of the Institution of Electrical Engineers for the session 1900–1901.

MR. BORCHGREVINK, who recently returned from his explorations in the Antarctic, will, it is expected, give a lecture before the Royal Geographical Society on June 18.

THE American Academy of Arts and Sciences has decided to award the Rumford medal to Prof. Carl Barus, of Brown University, for his researches in heat.

WE learn from *Science* that the Committee of Coinage, Weights and Measures of the U.S. House of Representatives has unanimously agreed to report as an amendment to the Sundry Civil Bill the measure establishing a United States Standardising Bureau, referred to in NATURE of May 17 (p. 61).

WE regret that a part of the edition of last week's NATURE appeared without the announcement that the names of Dr. D. Gill, F.R.S., and Dr. T. E. Thorpe, F.R.S., were included in the list of Birthday Honours. The former has been promoted to the rank of K.C.B., and the latter has been created a C.B.

THE third Liverpool expedition for the study of tropical diseases, referred to last week, will start in the first week in July. The members of the expedition are Drs. Durham and Walter Myers. The object of the expedition is to study yellow fever, malaria and dysentery.

AN excursion to Malvern and district has been arranged by the Geologists' Association for Whitsuntide. The director will be Prof. T. T. Groom, and during the stay at Malvern, from Saturday, June 2, to Tuesday, June 5, a number of interesting geological sections and structures will be examined.

A MEETING of the Yorkshire Naturalists' Union will be held at York on Whit-Monday for the investigation of the natural history of Askham Bog, and for the geological investigation of the morainic ridges of Askham and Bilbrough. Askham Bog is one of the very few undrained spots left in the Vale of York; hence the naturalist values it much as the palæontologist values one bone of an extinct animal, for from it he can draw such a true and interesting picture of a stage in the development of the district.

A FISHERIES Exhibition will be held at Salzburg, Austria, on September 2, and the eight following days. The exhibits are divided into nine classes, and include sections for artificial breeding apparatus, preserving methods, tackle, and the literature and statistics of fishing.

THE *Times* announces that the appointment of the commanding officer of the National Antarctic Expedition has been made by the joint committee of the Royal and Royal Geographical Societies. The officer selected is Lieut. Robert F. Scott, now torpedo-lieutenant of the *Majestic*. He has been fifteen years in the Navy, has a record of service of the highest class, and will shortly be promoted to commander. The head of the scientific staff will be Dr. J. W. Gregory, recently appointed professor of geology in the University of Melbourne. Though he has only just entered upon his duties at Melbourne, the authorities have granted him leave of absence to serve with the Antarctic Expedition. He will come to England in October to prepare for his new work.

AN exhibition of photographs, by Dr. P. H. Emerson, will be open at the Royal Photographic Society, 66 Russell Square, W.C., from May 30 until June 30.

BY the will of the late Prof. Piazzi Smyth, the executors are instructed to repay to the Government Grant Committee of the Royal Society all of the advances, estimated at 300*l*., made by the Society to Prof. Smyth for the purchase of scientific instruments after he went to Ripon. The will bequeaths to the Royal Society of Edinburgh the portrait of Prof. Smyth, by Faed, R.S.A., and all his books of original drawings and journals, and his boxes of glass photographs. The residuary estate is to be in trust for certain legatees for life, and subject to their life interest for the Royal Society of Edinburgh if agreeable to receive the same as a trust, whereof the income is to be employed by that Society, first, in printing for a limited free distribution and a small sale to the public, at a cost of about 600*l*., the spectroscopic MSS. offered by Prof. Smyth to the Government in October 1857, and then to assist or promote every ten or twenty years an exceptional expedition for the study of some particular branch of astronomical spectroscopy in the purer air of some mountain elevation of not less than 6000 feet above the sea-level, as tried and found feasible by him in the first experiment on the Peak of Teneriffe in 1856. If the residuary estate is not accepted by the Royal Society of Edinburgh, it is to be distributed amongst the pecuniary legatees.

LAST week the Royal Horticultural Society held its thirteenth "Temple Show." In every respect, apart from the uncertainty of the weather, the great annual exhibition more than fulfilled the expectation of lovers of flowers and of horticulturists generally. On the other hand, the botanist was greeted by no species that was not already known. The student of evolution might, nevertheless, have made the acquaintance of many new artificial races, and hours might have been spent in examining fresh garden "varieties," produced by hybridisation and cross-breeding. Even when some striking variation has been chanced upon, and "fixed" by careful selection, judicious crossing may be resorted to, in order that further "improvements" may be brought about. To take a case, Messrs. Laing and Sons showed some begonias, in which the development of a "crest" or tuft of small outgrowths from the petals was very much marked. This appeared sporadically and slightly at first in a plant with flowers of the same colour as those of its parents, but since the establishment of the crested race it has been crossed with others, and now crested petals may be had of many tints. The cactus-flowered zonal pelargonium may be mentioned on account of its vivid colouring and numerous narrow petals. Its rearer, Mr. E. S. Towell, obtained it from the seed of a "semi-double" *Pelargonium*, which he crossed with pollen from many different flowers. Among these was that of *Lychnis chalcedonica*; and Mr. Towell, though not absolutely certain of the fact, considers that the last-named species is the father of his "Fire Dragon." The particular tint of scarlet shown by the petals, the time these persist, and their divided appearance favour this view.

THE Sugar-Beet Committee of the Central Chamber of Agriculture have completed arrangements for a limited number of experiments in the growth of sugar-beet during the forthcoming season, each experimental plot being at least one acre in extent. In all, there will be about thirty-three different experiments, of which twenty-five are situated in England, four in Scotland, and four in Ireland. The English counties in which one or more experiments will be made are Wilts, Hants, Berks, Oxon, Beds, Kent, Suffolk, Hereford, Worcester, Warwick and Lancaster. As previous experiments have, in certain cases, demonstrated the value of sugar-beet for the feeding of live stock (independently of its value for the manufacture of sugar), it has been decided to keep this point specially in view in connection with the experiments of the present year.

AN interesting feature of the Paris Exposition is the elevated moving pavement. The line, which is described in the *Scientific American*, forms a complete circuit, running along the side of the Champ de Mars, the Quai d'Orsay, the Esplanade des Invalides and the Avenue de la Motte-Picquet, the total length of its course being 3500 metres. The platform is supported on an elevated structure, to which access is given from a number of stations situated within the Exposition grounds. The substructure supports three platforms, one fixed and two movable, these having a speed of eight and four kilometres per hour. To enable the platform to pass around the curves, the different sections are dovetailed into each other by large circular portions, forming a kind of horizontal hinge. Each of the platforms carries an I-beam running along under the centre; these rest upon a series of rollers placed at intervals, operated by electric motors. Upon the shaft of the motor is mounted a large roller for the high-speed platform and a roller of one-half the diameter for the slow speed. The friction of the platform is sufficient to cause its adhesion to the rollers. The platform was put into operation on April 14, and has proved a great success, as by its means an easy passage through the grounds is afforded, as well as a series of interesting views. The tour is made in twenty-six or fifty-two minutes.

PARTICULARS of the short electric line—about 5000 feet in length—between Earl's Court and High Street, Kensington, which has just been opened on the Metropolitan District Railway, are given in the current number of the *Electrician*. The engineers, Sir John Wolfe Barry and Sir W. H. Preece, were required to equip this line electrically without any interference with the permanent way, without any interference with the running of the ordinary train service, and without allowing any electric current to pass through the permanent way or the subsoil, lest such should interfere with the signalling arrangements of the line. In accordance with these stringent regulations, it became necessary to adopt an insulated system throughout, and to do the whole of the construction work in the few midnight hours when the trains were not running. The system may be termed a four-rail system. It includes the two ordinary track rails, which are not used for any electrical purpose whatever, and two electrical rail conductors placed on either side outside the track. A special type of train has been designed for the line, the design being such as to adapt it specially to the experimental conditions. There is no separate locomotive, the train being worked in block, and a motor carriage being placed at either end. Only one motor carriage, however, is used at a time—viz. that one in the front in the direction in which the train is moving. This arrangement, while duplicating the amount of electric motor plant, is convenient, as it obviates shunting the motor carriage. It is intended to carry out a series of careful experiments on electric traction upon this line, and for this purpose a dynamometer car will sometimes be attached to the train. Already certain experiments have been made. In his evidence before the Select Committee of the House of Commons considering the Manchester-Liverpool Express Railway, Sir William Preece recently stated that the train, fully loaded, had started on the very difficult gradient of 1 in 43—a feat which an ordinary steam locomotive was unable to perform when hauling a similar load. Moreover, in a tug-of-war between the electric train and a steam locomotive, the electric train readily overcame the steam engine.

IT has been said that every person is mentally a little unbalanced, and that education from this point of view is simply the attempt to secure and maintain mental equilibrium, which, however, is never actually attained. Lapses of thought, inadvertencies in expression, and other slips in speaking or writing (*lapsus linguae* and *lapsus calami*) are thus of interest to the psychologist as useful guides to the understanding of mental processes. Every one has experienced unaccountable lapses of this kind, and the lapse often comes as a surprise to the speaker or writer himself. During a lecture, a professor inadvertently referred to the "tropic of Cancercorn," intending to say "the tropics of Capricorn and of Cancer." Many similar instances might be cited, for example, the man who was going for a walk to "get a breash of freth air," the person who inquired for the "portar and mestle," and another who said "the pastor cut the shermon sort." A physicist is recorded to have said that he feared he should "get the instrument out of needle," when he intended to say he feared he would "get the instrument out of level and deflect the needle." This is curious, but it is not so amusing as the order of "beggs and acon" for breakfast, or the remark of a nervous churchman to a stranger in his seat, "Excuse me, but you are occupuing my pie." Mr. H. Heath Bawden has made a detailed study of similar mental lapses, both oral and graphic, and his results are described in a monograph of the *Psychological Review*. It is suggested that the aberrations dealt with are due to incipient aphasia or agraphia, and the similarity between them is held to show that our ordinary experience borders at every point on what is called the abnormal or pathological condition.

FOR some time past peat has been largely used in this country as litter for stables in the place of straw. This material is now likely to have a much more extended use, and the peat bogs of this and other countries made to assume a value never before realised. For the past twelve years Herr Zschörner, of Vienna, has been investigating the properties of peat, and has shown its possibilities. In the Vienna Exhibition of last year was a building in which everything, from the carpets on the floor to the curtains on the windows, and the paper on the walls, had all been made from peat. Herr Zschörner's investigations have shown that, although the fibres of the remains of the reeds and grasses of which peat is composed have become altered in their physical and chemical character, yet they have not suffered any anatomical change; and while nothing capable of fermentation or decay is left, the fibrous structure remains intact; that they are very durable, elastic, good non-conductors of heat and non-combustible. Fabrics woven from them are found to have the toughness of linen with the warmth of wool. There is no textile fabric that cannot be woven from these fibres. Blankets and other coverings used for horses and cattle have been found in use to excel in warmth and cleanliness. The unspun fibre is found to be a good substitute for absorbent cottons possessing strong antiseptic properties. Paper of several qualities has been made, and the uses to which peat fibre has already been applied indicate possibilities that may render the peat bogs of Ireland a valuable addition to the resources of that country, and give full occupation to the inhabitants of the "congested" districts.

THE *Rendiconto* of the Naples Academy for March and April contains a complete list of the mathematical works of the late Prof. Beltrami.

IN the *Bulletin de la Classe des Sciences* of the Belgian Academy, M. Vandenberghe continues his researches on the dissociation of substances in solution. The author, by new experiments conducted with the use of solvents belonging to the same homologous series, establishes the conclusion that the influence exerted on the decomposition of molecular associations by the solvent does not materially influence the effects due to elevation of temperature.

A PRELIMINARY note on the magnetic observations made during the *Belgica* Antarctic expedition is given by M. G. Lecointe in the *Bulletin de la Classe des Sciences* (Brussels). For the measurements of declination Neumayer's apparatus was used, the declination being the difference between the magnetic azimuth of a star and the true azimuth calculated from the local time. The Neumayer apparatus was also found far more suitable than the theodolite for measuring the horizontal component, the instability of the theodolite as its feet began to sink into the ice rendering observations made with it of little value. In determining the inclination the great sensitiveness of Gambey's compass could not be utilised regularly on account of the ice-movements, and here again Neumayer's apparatus proved the most serviceable. The paper consists chiefly of a table of the recorded observations.

IN his Wilde Lecture, published in the *Manchester Memoirs*, 1899, No. 5, Lord Rayleigh discusses the mechanical principles and possibilities of flight, both natural and artificial. The problem of the sailing bird is treated from the three alternative points of view, which attribute its source of energy to upward currents, variation of wind-velocity with the altitude and pulsating gusts of wind. Lord Rayleigh then considers the law of dependance of the aerial resistance of a plane surface on its obliquity, and describes experimental methods whereby the resistances at different obliquities may be compared by an "astatic" arrangement, in which pairs of vanes are so adjusted that the moments of the oppositely turned vanes balance each other. In connection with the expenditure of power required to support a given weight, Lord Rayleigh has calculated that, in order for a man to support himself by a *vertical* screw by working at the power an average man can maintain for eight hours a day, he would require a screw ninety metres in diameter, and in this estimate no account has been taken of the weight of the mechanism or of frictional losses. In conclusion, the effects of flapping wings are briefly discussed.

A FURTHER addition to Mr. H. C. Russell's interesting current papers (No. 4), containing the tracks of 124 bottles received during a year ending with September last, has been published. The comparatively large number of bottles received appears to be owing to the prevalence of southerly winds; the north-west winds being found to alter the direction of the drifting bottles, so that they pass to the south of Australia. The suggestion made in the previous paper that bottles thrown over on the east coast drifted first to the east in Tasman Sea, and then northwards until they reached the great current from the east, which passes south of New Caledonia, is supported in a remarkable way by the drift of the *Perthshire* after she was disabled in the Tasman Sea; her general direction for 640 miles was N.E. by N., at an average daily rate of 13·6 miles. Towards the end of the drift she travelled rapidly to the west. Two bottles floated near Cape Horn came over to Australia at the daily rates of 12·2 and 9·5 miles respectively. There are also some very interesting bottle tracks in the North Atlantic Ocean. One of these, floated in the Gulf of Mexico, made a run of 6300 miles in a south-easterly direction—the longest hitherto recorded in that ocean by Mr. Russell. The proportion of bottles received to those thrown overboard appears to be very disappointing; out of 48 bottles thrown from ss. *Gulf of Bothnia*, to take an extreme case, only one was received.

THE resolutions passed at the International Congress for Marine Research held at Stockholm last summer are published *in extenso* in the April number of the *Scottish Geographical Magazine*. An important feature in these resolutions is the recognition that the primary object of the investigations recommended to be undertaken is the improvement and promotion of fisheries by means of international agreements.

IN *Appleton's Popular Science Monthly* for May, Prof. E. S. Morse gives a full account of the observations made by himself many years ago as to the manner in which the larval insect known as the "cuckoo-spit" forms the mass of froth in which it is concealed. If the insect be cleared from the mass of froth and allowed to settle upon some succulent plant-stem, it will soon thrust its piercing organs through the outer layers and commence sucking the juices. After a short time a clear fluid exudes from the abdomen, and after flowing over the body eventually fills up the spaces between the latter, the legs and the stem, so that the entire creature is soon totally enveloped. For about half an hour the insect will remain quiescent in this condition, when it suddenly begins to "blow bubbles" by turning its tail out of the fluid, opening the terminal segment, which appears like claspers, and then bending down the tail into the fluid with an attached air-bubble, which is instantly allowed to escape. These movements are repeated at the rate of 70 or 80 a minute till the entire envelope of fluid is converted into the mass of froth with which we are all familiar.

Bulletin No. 23 of the Division of Entomology of the U.S. Department of Agriculture is devoted to a series of articles, by Mr. F. H. Chittenden, dealing with some of the insects injurious to garden crops. Sixteen different species of such pests are described, with the devastation they cause. Out of these, the most generally interesting is the invasion of the "fall army-worm" in 1899. This caterpillar (*Laphygma frugiperda*) derives its name from the circumstance that, unlike the true "army-worm," it is seldom observed, except perhaps in the most Southern States, to travel in large hosts until the autumn, or, at least, before August. During 1899 these caterpillars appeared in vast swarms over a large area of the States, where they inflicted much damage on crops of various kinds. Properly speaking, the "fall army-worm" is a grass-feeder, but when it makes its appearance in such numbers as to consume all accessible pasture in the neighbourhood, as was the case last season, it turns its attention to gardens, orchards and greenhouses. The crops affected last year, in addition to grass and clover, included rice, maize, wheat, oats, cabbage, beet, peas, turnips and even tobacco. Unfortunately, the "fal army-worm" differs from the true "army-worm" in that its hosts may reappear the year after a visitation; and destructive measures, such as poisoning by kerosene or arsenic, are accordingly essential.

WE have received the *Proceedings* of the South London Entomological and Natural History Society for 1899, which includes the President's address and several original communications on entomological subjects.

THE latest issue of the *Natural History Transactions* of Northumberland, Durham, &c., contains a catalogue of the unique and unrivalled collection of British birds presented in 1883 to the trustees of the Natural History Society of those counties by the late John Hancock. The catalogue has been drawn up by Mr. J. Howse.

THERE are already several excellent editions of Gilbert White's "Selborne," but a welcome will be extended to the splendid volumes, the first of which has just been published by Mr. S. T. Freemantle. In this edition we shall have in two volumes a superb "Natural History and Antiquities of Selborne, and a Garden Kalendar," edited by Dr. R. Bowdler Sharpe, with an introduction to the Garden Calendar by Dean Hole, and numerous plates and other illustrations.

"LA SPÉLÉOLOGIE" is the title of a little handbook by M. E. A. Martel on the science of caverns. It belongs to the "Scientia" series, published by MM. Carré et Naud (Paris, 1900; pp. 126). The author gives an account of the origin of fissures and caverns, of the action of subterranean waters and all matters connected with them. He deals also with the phenomena of ice-caves (*glacières*), and again with the relations between rock cavities and metalliferous deposits. The various prehistoric and historic remains found in caverns are somewhat briefly dealt with; and finally the author discourses on the plants and animals found living in subterranean regions.

MR. W. ENGELMANN, of Leipzig, has just commenced the publication of an elaborate work, by Prof. W. Wundt, entitled "Völkerpsychologie: Eine Untersuchung der Entwicklungsgesetze von Sprache, Mythus, und Sitte." The work will be completed in three volumes—the first dealing with language as the expression of the emotions by signs and speech, the second with myths and religions, and the third with ceremonies and customs. Each volume will be complete in itself, and will be separately indexed. The second (and concluding) part of the first volume will be published in the autumn of this year, and will then be reviewed with the part which has just appeared.

DR. ROBERT MUNRO'S "Rambles and Studies in Bosnia-Herzegovina and Dalmatia" (Blackwood) is not only an excellent book of travel, but a very valuable contribution to archæological literature. An appreciative notice of the work appeared in these columns four years ago (vol. liv. p. 78), and we have now to announce the publication of a second, revised and enlarged edition. An account is given of the proceedings of the Congress of Archæologists and Anthropologists held at Sarajevo in August 1894, and as the Government of Bosnia-Herzegovina have departed from their original intention to publish a report of the congress, Dr. Munro's volume has the distinction of being the only record, in book form, of the important problems which were considered. A number of additions have been made to the original volume, and a much-wanted index has been supplied.

THE second and third parts of the second volume of the unique "Encyklopädie der mathematischen Wissenschaften" in course of publication by the firm of B. G. Teubner, Leipzig, have just been issued. The scope of this great undertaking is so extensive that several years must elapse before the work is completed. There will be seven volumes in all, having the following subjects and editors:—Arithmetic and algebra, Prof. W. F. Meyer; analysis, Prof. H. Burkhardt; geometry, Prof. Meyer; mechanics, Prof. F. Klein; physics, Prof. A. Sommerfeld; geodesy and geophysics, Prof. E. Wiechert; astronomy (under arrangement); history, philosophy, and didactic questions, Prof. Meyer. The work is published under the auspices of the Munich and Vienna Academies of Science, and the Göttingen Society of Sciences, and no mathematical library will be complete without it.

SIR JOHN LUBBOCK'S book on "The Scenery of Switzerland, and the causes to which it is due" has been translated into Italian by Dr. L. Scotti, and is published by Signor U. Hoepli, of Milan, as "Le Bellezze della Svizzera, Descrizione del Paesaggio e sue Cause geologiche." The first English edition was noticed in NATURE of September 10, 1896 (vol. liv. p. 439); the translation is from the third edition, published in 1898.

THE use of acetylene for lighting rooms upon a commercial scale renders its purification from sulphuretted and phosphuretted hydrogen imperative, on account of the injurious effects of the products of combustion of these impurities in a confined space. Numerous substances have been put forward by different inventors as effecting the desired purification, among which may be mentioned ferric chloride, chromium sulphate, petroleum, benzene, chromic acid, bleaching powder, and cuprous chloride. The ideal purifier should remove the impurities as completely as possible, should not absorb acetylene itself, and should not communicate any objectionable properties to the purified gas. The current number of the *Moniteur Scientifique* contains abstracts of numerous papers upon this subject. From these it would appear that solutions of metallic salts do not wholly remove the impurities, chromic acid and chloride of lime solutions being the only substances that effect a complete purification, and of these the former is preferable, as with the latter explosions have occurred, probably owing to the formation of chloro-acetylene.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, a Common Squirrel (*Sciurus vulgaris*), British, presented by Mrs. Morris; a Common Paradoxure (*Paradoxurus niger*) from Java, presented by Mr. E. E. Hewens; a Boddaert's Snake (*Drymobius boddaerti*), a Chequered Elaps (*Elaps lemniscatus*), a Rat-tailed Opossum (*Didelphys nudicaudata*) from Trinidad, presented by Mr. Leon Bernstein; a Summer Snake (*Contia oestiva*), a Mexican Snake (*Coluber melanoleucus*), six Menobranches (*Necturus maculatus*), five American Green Frogs (*Rana halecina*) from North America, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE.

June 2. 8h. 33m. to 9h. 35m. Moon occults κ Cancri (mag. 5·0).

4. 9h. 49m. to 10h. 45m. Transit of Jupiter's Satellite III. (Ganymede).

7. 9h. 58m. to 10h. 55m. Moon occults the star D.M. – 10°, 3570 (mag. 6·0).

11. 8h. Jupiter in conjunction with moon. Jupiter 1° 29′ North.

11. 11h. 23m. to 12h. 43m. Transit of Jupiter's Satellite III. (Ganymede).

12. Partial eclipse of the moon.
 13h. 16·2m. First contact with penumbra.
 15h. 24·2m. First contact with shadow.
 15h. 27·6m. Middle of the eclipse.
 15h. 31·0m. Last contact with the shadow.

June 12. 17h. 39·0m. Last contact with the penumbra.
 It will be a very small eclipse, the proportion of the moon's surface covered by the earth's shadow being equal to only one-thousandth part. The fainter outlying shadow will, however, cover a large region, but will be only faintly discernible.

13. 7h. Mercury in conjunction wtih ϵ Geminorum. Mercury, 0° 3′ South.

13. 9h. 40m. to 10h. 52m. Moon occults the planet Saturn.

15. Venus. Illuminated portion of disc, 0·144. Mars, 0·962.

16. 8h. 48m. Jupiter's Satellite IV. (Callisto) in conjunction south of planet.

19. Saturn. Polar semi-diameter, 17″·0. Outer minor axis of outer ring, 18″·87.

23. 5h. Saturn in opposition to sun.

SEARCH EPHEMERIS FOR EROS.—The following is continued from the ephemeris by J. B. Westhaver (*Astronomical Journal*, No. 479, vol. xx. p. 185).

Ephemeris for 12h. Greenwich Mean Time.

1900.	R.A. h. m. s.	Decl. ° ′ ″	Mag.
June 2	23 57 2·6	+4 22 22	...
4	0 36·1	4 57 6	12·9
6	4 8·7	5 31 57	...
8	7 40·7	6 6 57	12·9
10	11 11·9	6 42 6	...
12	14 42·5	7 17 24	12·8
14	18 12·4	7 52 51	...
16	21 41·7	8 28 27	12·7
18	25 10·3	9 4 12	...
20	28 38·1	9 40 5	12·7
22	32 5·3	10 16 8	...
24	35 31·8	10 52 19	12·6
26	38 57·5	11 28 39	...
28	42 22·4	12 5 8	12·5
30	45 46·6	12 41 47	...
July 2	49 10·0	13 18 34	12·5

Prof. Howe is reported to have discovered the planet in the constellation Aries.

OXFORD UNIVERSITY OBSERVATORY.—In the twenty-fifth annual report of the Savilian professor at Oxford, Prof. H. H. Turner briefly reviews the history of the institution. The late Prof. Pritchard, in 1873, successfully appealed to the University for facilities to institute the means of carrying on astronomical research, but the plans originally projected being modified by the presentation of Dr. De la Rue's instruments, the building was not finished until 1875. However, notwithstanding his advanced age, Prof. Pritchard carried out before his death two important researches, the *Uranometria Nova Oxoniensis*, and the determination of stellar parallaxes; and initiated a third, the share of the Observatory in the International Astrographic Chart.

During the six years of Prof. Turner's directorship the energies of the Observatory have been chiefly directed to carrying out, as expeditiously and economically as is consistent with the necessary accuracy, this great work of fundamental astronomy. One or two more years will be required to complete it, but the work is at present as well advanced as at any of the other eighteen observatories which are collaborating. In addition, the Observatory has been utilised as an educational institution for the benefit of the students of the University.

For the Astrographic Catalogue, 736 plates are now measured, and 705 completely reduced, out of the 1180 falling to the share of the Observatory. Measurements have been made on a plate supplied by Prof. E. C. Pickering to determine the optical distortion of a photographic doublet. A preliminary discussion of these measures indicates a distortion varying as the cube of the distance from the centre of the plate; this somewhat surprising result, if confirmed, will enable the reduction of photographs of star fields of wide angle to be made with great accuracy.

ROUSDON OBSERVATORY, DEVON.—Sir C. E. Peek sends us another of his pamphlets (No. 6), containing the detailed particulars of the observations of variable stars during the past decade. The observations of T Cassiopeiæ extend over the ten years 1889–1898, and those of R Cassiopeiæ from 1887–1898. At the end of the observation the light curves of the two stars are shown.

SOME MODERN EXPLOSIVES.[1]

II.

I NOW pass to points which have to be considered when weighing the comparative merits of explosives for their intended ends.

You will easily understand that between explosives which are intended to be used for propelling purposes, and those which are intended to be used, say for bursting shell, a wide difference may exist.

In the former case, facility of detonation would be an insuperable objection; in the latter, the more perfect the detonation the better, certain special cases, to which I have not time to refer, excepted.

There exists, I think, considerable diversity of opinion as to what does, and what does not, constitute true detonation. I find many persons speak of a detonation, when I should merely consider that a very high pressure had been reached. This gun-cotton slab on the table affords me, I think, a fair opportunity of explaining my meaning. Were I to set fire to it, except for the large volume of flame and the great amount of heat generated, we in this room would not suffer; we should probably experience more inconvenience did I fire a similar slab of gunpowder, as detached burning portions would probably be projected to some distance.

But if I fired this same slab with two or three grammes of fulminate of mercury, a detonation of extreme violence would follow. The detonation would be capable of blowing a hole in a tolerably thick iron plate, and would probably put an end to a considerable portion of the managers in the front row.

I mentioned to you some time ago the time in which a charge would be consumed in the chamber of a gun—if a charge of 500 lbs. of these slabs were effectively detonated, this charge would be converted into gas in less than the 20,000th part of a second.

No such result would follow were I to try a similar experiment with a slab of compressed gunpowder of the same dimensions. I do not say the experience would be pleasant, but there would be nothing of the instantaneous violent action which marks the decomposition of the gun-cotton.

To give you an idea of the extraordinary violence which accompanies detonation, I have fired, for the purpose of this lecture, with fulminate of mercury, a charge of lyddite in a cast-iron shell, and those who are sufficiently near can see for themselves the result. By far the greater part of the cast-iron shell, weighing about 10 lbs., is reduced to dust, some of which is so fine that I assumed it to be deposited carbon until I had tested it with a magnet. I may add that the indentation of the steel vessel by pieces of the iron which were not reduced to powder would appear to indicate velocities of not less than 1200 feet-seconds, and this velocity must have been communicated to the fragments in a space of less than two inches.

For the sake of comparison, I place beside it a cast-iron shell burst by gunpowder. You will observe the extraordinary difference. I also have on the table two small steel shells exploded, one by a perfectly detonated, the other by a partially detonated charge. I may remark that in the accounts of correspondents from the seat of war, frequent mention is made of the green smoke of lyddite. This appearance is due probably to imperfect detonation—to a mixture, in fact, of the yellow picric with the black smoke. I do not say, however, that imperfect detonation is necessarily an evil.

To another experiment I draw your attention.

For certain purposes I caused to be detonated, in the chamber of a 12-pounder, a steel shell charged with lyddite. The detonation was not perfect, but the base of the shell was projected with great violence against the breech screw. You may judge of how great that violence was when I tell you that the base of the shell took a complete impression of the recess for the primer, developing great heat in so doing; but, what was still more remarkable, the central portion of the base also sheared, passing into the central hole through which the striker passes. This piece of shell is upon the table, and open to your inspection.

One other instance to illustrate the difference between combustion and detonation I trouble you with. Desiring to ascertain the difference, if any, in the products of explosion between combustion and detonation, I fired a charge of lyddite in such a manner that detonation did not follow. The lyddite merely deflagrated. But a similar charge differently fired shortly afterwards detonated with such extreme violence as to destroy the vessel in which it was exploded. The manner in which the vessel failed I now show you (Fig. 4), and I have on the table the internal crusher gauge which was used, and which was also totally destroyed.

The condition of this gauge is very remarkable, and the action on the copper cylinder employed to measure the pressure was one to which I have no parallel in the many thousand experiments I have made with these gauges. The gauge itself is fractured in the most extraordinary way, even in some places to which the gas had no access, and the copper cylinder, which when compressed usually assumes a barrel-like form (that is, with the central diameter larger than that at the ends as shown in Fig. 5); but in this experiment, and in this only, the cylinder was bulged closed to the piston, as you see. It would appear as if the blow was so suddenly given that the laminæ of the metal next the piston endeavoured to escape in the direction of

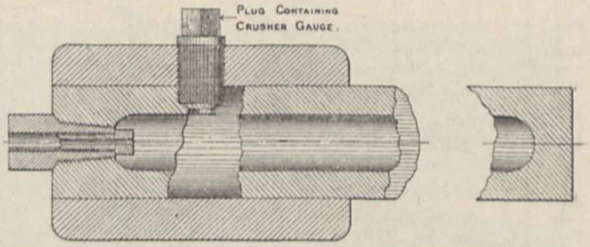


FIG. 4.—Explosion vessel.

least resistance, that being easier than to overcome the inertia of the laminæ below.

The erosive effect of the new explosives is another point of first-rate importance in an artillery point of view. The cordite of the service is not, if the effect be estimated in relation to the energy impressed on the projectiles, more erosive than, for example, brown prismatic, which was itself a very erosive powder; but as we are able to obtain, as you have seen, very much higher energies with cordite than with brown prismatic, the erosion of the former is, for a given number of rounds, materially higher.

There is, however, one striking difference. By the kindness of Colonel Bainbridge, the Chief Superintendent of Ordnance Factories, I am enabled to show you a section of the barrel of a large gun eroded by 137 rounds of gunpowder. Beside it is a barrel of a 4·7-inch quick-firing gun eroded by 1087 rounds of gunpowder, and another eroded by 1292 rounds of cordite. You will observe the difference. In the former case the erosion much resembles a ploughed field. In the latter the appearance is more, as if the surface were washed away by the flow of the highly heated gases.

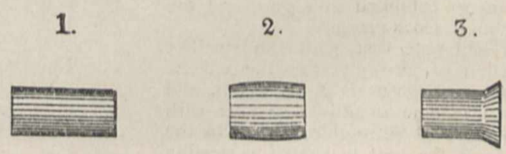


FIG. 5.—Copper cylinders.

But take it in what way you please, the heavy erosion of the guns of the service, if fired with the maximum charges, is a very serious matter, as with the large guns, accuracy, and in a smaller degree energy, are rapidly lost after a comparatively small number of rounds have been fired.

Cordite was first produced for use in small arms only, where, owing to the small charges employed, the question of erosion is not of the same importance as with large guns; but its employment, from the great results obtained with it, was rapidly extended to artillery, and the attention of my friends, Sir F. Abel and Prof. Dewar, has for some time been devoted in conjunction with myself to investigating whether it is not possible materially to reduce this most objectionable erosion.

With this object I made the following series of experiments.

[1] A Discourse delivered at the Royal Institution on Friday, March 23, by Sir Andrew Noble, K.C.B., F.R.S. Continued from p. 90.

I had cordite of the same dimensions prepared with varying proportions of nitro-glycerine and gun-cotton. The nitro-glycerine being successively in the proportions of 60, 50, 40, 30, 20 and 10 per cent., and with each of these cordites I determined the following points :—

(1) The quantity of permanent gases generated.
(2) The amount of aqueous vapour formed.
(3) The heat generated by the explosion.

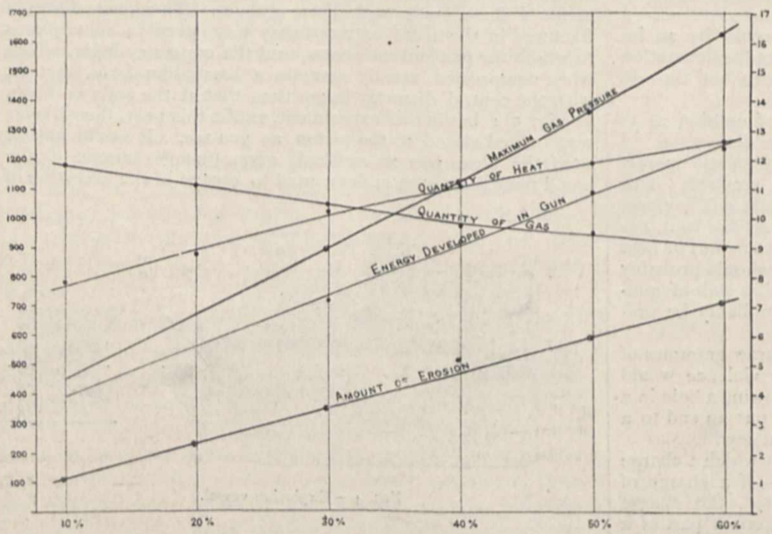


FIG. 6.—Energy in foot tons ; heat in units ; gas in c.c. ; erosion in inches ; pressure in tons.

(4) The erosive effect of the gases.
(5) The ballistic energy developed in a gun, and the corresponding maximum pressure.
(6) The capacity of the cordite to resist detonation when fired with a strong charge of fulminate of mercury.

The results of these experiments were both interesting and instructive.

To avoid wearying you with a crowd of figures, I have placed on Fig. 6 the results of the first five series of experiments.

On the axis of abscissæ are placed the percentages of nitro-glycerine, while the ordinates show the quantities of the gases generated, the amount of heat developed, the erosive effect of the explosive, the ballistic energy exhibited in a gun, and the maximum gaseous pressure.

You will note that with the smallest proportion of nitro-glycerine the volume of permanent gases is a maximum, and that the volume steadily decreases with the increase of nitro-glycerine. On the other hand, the heat generated as steadily increases with the nitro-glycerine, and if we take the product of the quantity of heat and the quantity of gas as an approximate measure of the potential energy of the explosive, the higher proportion of nitro-glycerine has an undoubted advantage; but in this case, as in the case of every other explosive with which I have experimented, the potential energies differ less than might be expected from the changes in transformation, as the effect of a large quantity of gas is to a great extent compensated by a great reduction in the quantity of heat generated.

This effect is, of course, easily explained, and was very strikingly exhibited in the much more complicated transformation experienced by gunpowders of different compositions, a long series of which were very fully investigated by Sir F. Abel and myself.

Looking at this diagram you will have observed that the energy developed in the gun is very much smaller with the smaller proportions of nitro-glycerine, but if you will look at the corresponding maximum pressure-curve you will note that the pressures have decreased nearly in like proportion. Hence it is probable that the lower effect is mainly due to a slower combustion of the cordite, and it follows that this effect may be, to a great extent, remedied by increasing the rate of combustion by reducing the diameter of the cordite to correspond with the reduction in the quantity of nitro-glycerine.

To test this point I caused to be manufactured a second series of cordites of the same composition, but with the diameters successively reduced by ·03, as you see with the samples I hold, and this diagram (Fig. 7) shows at a glance the result. The energies you see are, roughly, practically the same, but if you look at the pressure-curve you will observe that I have obtained a curve in which, on the whole, the pressures vary in the contrary direction, that is to say, in this case the pressures increase as the nitro-glycerine diminishes.

Taking the two series into account, they show that by a proper arrangement of amount of charge and diameter of cord it would be possible to obtain the same ballistics and approximately the same pressure from any of the samples I have exhibited to you.

But I have to draw your attention to another point. From the curve showing the quantities of heat you will note that in passing from 10 per cent. nitro-glycerine to 60 per cent., the heat generated has increased by about 60 per cent. But here is the curve indicating the corresponding amount of erosion, and you will see that while the quantity of heat is only greater by about 60 per cent., the erosion is greater by nearly 500 per cent.

These experiments entirely confirm the conclusion at which I have previously arrived, viz. that heat is the principal factor in determining the amount of erosion.

In experimenting with a number of alloys of steel, the greatest resistance was shown by an alloy of steel with a small proportion of tungsten, but the difference between the whole of these amounted only to about 16 per cent.

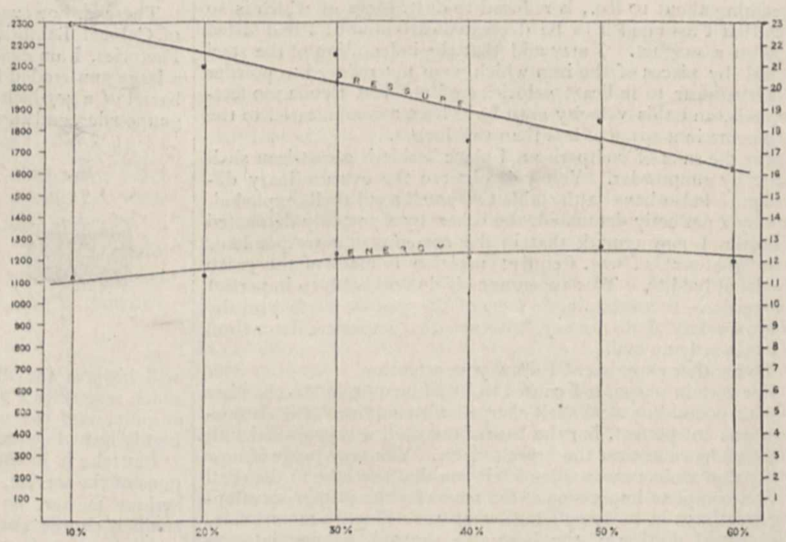


FIG. 7.—Energy in foot tons ; pressure in tons.

The whole of these cordites were, as I have mentioned, subjected to detonation tests. None of them, so far as my experiments went, exhibited any special tendency in this direction.

I will now endeavour to describe to you a most interesting and important series of experiments which, I regret to say, is a long way from completion.

The objects of these experiments were (1) to ascertain the time required for the combustion of charges of cordite in which the cordite was of different thicknesses, varying from 0·05 inch to 0·60 of an inch; (2) the rapidity with which the explosives part with their heat to the vessel in which the charge is confined; and (3) to ascertain, if possible, by direct measurement, the temperature of explosion, and to determine the relation between the pressure and temperature at pressures approximating to those which exist in the bore of a gun, and which are, of course, greatly above any which have yet been determined.

As regards the first two objects I have named, I have had no serious difficulties to contend with, but as regards the third, I have so far had no satisfactory results, having been unable to use Sir W. Roberts Austen's beautiful instrument owing to the temperature at the moment of explosion being greatly too high, high enough indeed to melt and volatilise the wires.

I am, however, endeavouring to make an arrangement by which I hope to be able to determine these points when the temperature is so far reduced that the wires will no longer be fused.

If the piston be left free to move the instant of the commencement of pressure, the outside limit of the time of complete explosion will be indicated; but, on account of the inertia of the moving parts, the pressure indicated will be in excess of the true pressure, and the excess will be, more or less, inversely as the time occupied by the explosion.

If we desire to know the true pressure, it is necessary to compress the gauge beforehand to a point closely approximating to the expected pressure, so that the inertia of the moving parts may be as small as possible—the arrangement by which this is effected is not shown in the photograph, but the gauge is retained at the desired pressure by a wedge-shaped stop, held in its place by the pressure of the spring, and to the stop a heavy weight is attached—when the pressure is relieved by the explosion, the weight falls and leaves the spring free to act.

I have made a large number of experiments with this instrument, both with a variety of explosives and with explosives fired under different conditions. Time will not permit me to do more than to show you on the screen three pairs of experiments to

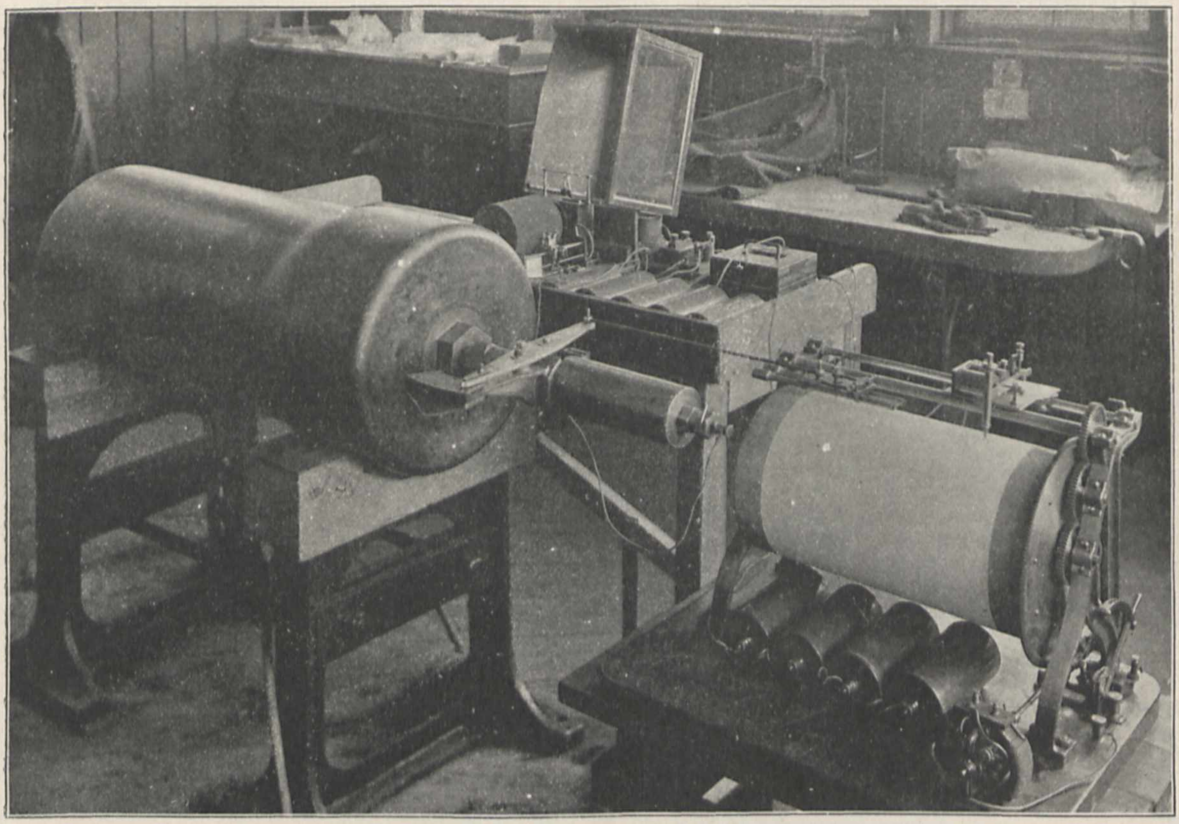


FIG. 8.

illustrate the effect of exploding cordite of different dimensions, but of precisely the same composition.

I shall commence with rifle cordite. In this diagram (Fig. 9) the axis of abscissæ has the time in seconds marked upon it, while the ordinates denote the pressures, and I draw your attention to the great difference, in the initial stage, between the red and the blue curves. You will notice that the red curves show a maximum pressure some $4\frac{1}{2}$ tons higher than that shown by the blue curve; but this pressure is not real. It is due to the inertia of the moving parts. The red and blue curves in a very small fraction of a second come together, and remain practically together for the rest of their course. The whole of the charge is consumed in something less than fifteen thousandths (·015) of a second.

In the case of the blue curve the maximum pressure indicated is obtained in the way I have described, and is approximately correct—about nine tons per square inch. The rapidity with which this considerable charge parts with its heat by communication to

The apparatus I have used for these experiments is placed on the table. The cylinder in which the explosives were made is too heavy to transport here, but this photograph (Fig. 8) will sufficiently explain the arrangement. The charge I used is a little more than a kilogramme, and it is fired in this cylinder in the usual manner.

The tension of the gas acting on the piston compresses the spring, and indicates the pressure on the scale here shown. But to obtain a permanent record, the apparatus I have mentioned is employed.

There is, you see, a drum made to rotate by means of a small motor. Its rate of rotation is given by a chronometer acting on a relay, and marking seconds on the drum, while the magnitude of the pressure is registered by this pencil actuated by the pressure-gauge I have just described.

To obtain with sufficient accuracy the maximum pressure, and also the time taken to gasify the explosive, two observations—that is, two explosions—are necessary.

the explosion vessel is very striking. In four seconds after the explosion the pressure is reduced to about one-half, and in twelve seconds to about one-quarter.

I now show you (Fig. 10) similar curves for cordite 0·35 inch in diameter, or about fifty times the section. Here you see that the time taken to consume the charge is longer. The effect of inertia is still very marked, although much reduced. The true maximum pressure is little over 8·5 tons, but after the first third of a second the two curves run so close together that they are indistinguishable.

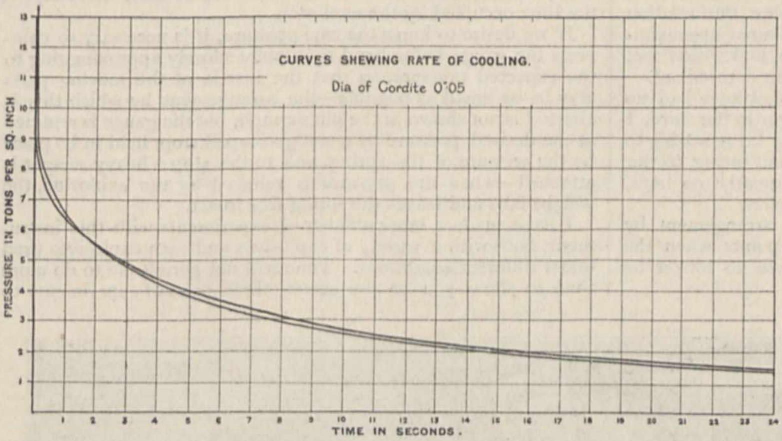


FIG. 9.

Again, you see the pressure is reduced by one-half in four seconds, and in a little more than twelve seconds again halved.

The last pair of curves I shall show (Fig. 11) you was obtained with cordite 0·6 inch in diameter, or nearly 150 times the section of the rifle cordite. With this cordite the combustion has been so slow that the effect of inertia almost disappears; it is reduced to about half a ton per square inch. The maximum being nearly the same as in the last set of experiments. The time of combustion indicated I have called slow, but it is about ·06 of a second, and the whole of the experiments show a most remarkable regularity in their rate of cooling, the pressures at the same distance of time from the explosion being in all cases approximately the same—as, indeed, they ought to be. The density being the same and the explosive the same, the only difference being the time in which the decomposition is completed.

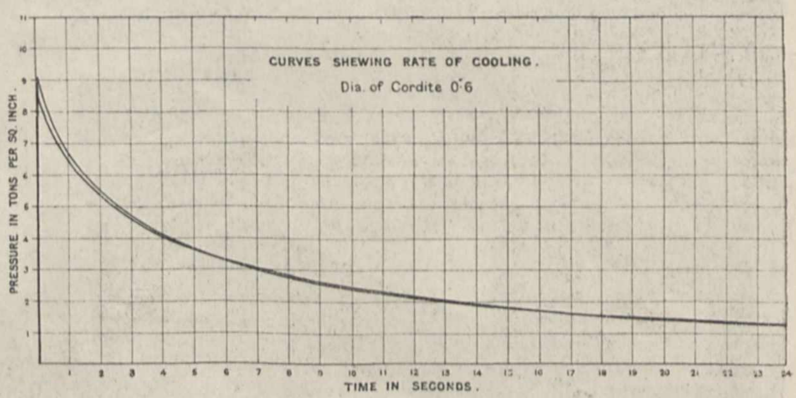


FIG. 11.

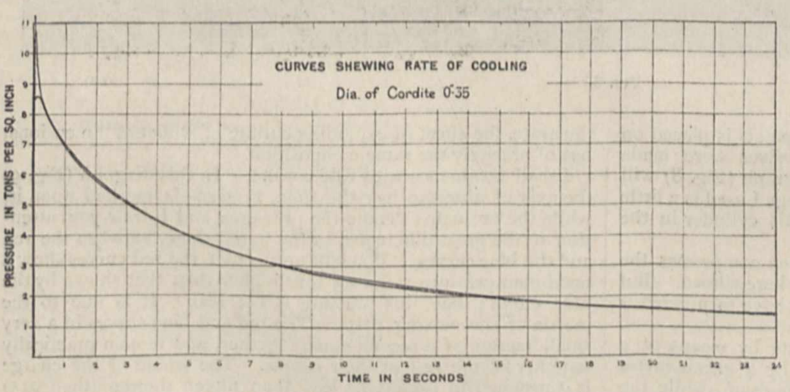


FIG. 10.

It appears to me that, knowing from the experiments I have described, the volume of gas liberated, its composition, its density, its pressure, the quantity of heat disengaged by the explosion; and knowing all these points with very considerable accuracy, we should be able, from the study of the curves to which I have drawn your attention, and which can be obtained from different densities of gas, to throw considerable light upon the kinetic theory of real, not ideal gases, at temperatures and pressures far removed from those which have been the subject of such careful and accurate research by many distinguished physicists.

The question, as I have said, involves some very considerable difficulties; nevertheless, I am not without hope that the experiments I have been describing may, in some small degree, add to our knowledge of the kinetic theory of gas.

That wonderful theory faintly shadowed forth almost from the commencement of philosophic thought, was first distinctly put forward by Daniel Bernoulli early in the last century. In the latter half of the century now drawing to a close the labours of Joule, Clausius, Clerk Maxwell, Lord Kelvin and others have placed the theory in a position analogous and equal to that held by the undulatory theory of light.

The kinetic theory has, however, for us artillerists a special charm, because it indicates that the velocity communicated to a projectile in the bore of a gun is due to the bombardment of that projectile by myriads of small projectiles moving at enormous speeds, and parting with the energy they possess by impact to the projectile.

There are few minds which are not more or less affected by the infinitely great and the infinitely little.

It was said that the telescope which revealed to us infinite space was balanced by the microscope which showed us the infinitely small; but the labours of the men to whom I have referred have introduced us to magnitudes and weights infinitesimally smaller than anything that the microscope can show us, and to numbers which are infinite to our finite comprehension.

Let me draw your attention again to this figure (Fig. 2) showing the velocity impressed upon the projectile, and let me endeavour to describe the nature of the forces which acted upon it to give it its motion. I hold in my hand a cubic centimetre, a cube so small that I daresay it is hardly visible to those at a distance. Well, if this cube were filled with the gases produced by the explosion at 0° C. and atmospheric pressure, there would be something over seven trillions, that is, seven followed by eighteen cyphers, of molecules. Large as these numbers are, they occupy but a very small fraction of the contents of the cubic centimetre, but yet their number is so great that they would, if placed in line touching one another, go round many times the circumference of the earth, a pretty fair illustration of Euclid's definition of a line.

These molecules, however, are not at rest, but are moving, even at the low temperature I have named, with great velocity, the molecules of the different gases moving with different velocities dependent upon their molecular weight. Thus, the hydrogen molecules which have the highest velocity move with about 5500 feet-seconds mean velocity, while the slowest, the carbonic anhydride molecules, have only 1150 feet-seconds mean velocity, or about the speed of sound.

But in the particular gun under discussion, when the charge was exploded there were no less than 20,500 cubic centimetres of gas, and each centimetre at the density of explosion contained 580 times the quantity of gas—that is, 580 times the number of molecules that I mentioned. Hence the total number of molecules in the exploded charge is $8\frac{1}{4}$ quadrillions, or let us say approximately for the total number eight followed by twenty-four cyphers.

It is difficult for the mind to appreciate what this immense number means, but it may convey a good idea if I tell you that if a man were to count continuously at the rate of three a second, it would take him 265 billions of years to perform the task of counting them.

So much for the numbers; now let me tell you of the velocities with which, at the moment of explosion, the molecules were moving. Taking first the high-velocity gas, the hydrogen, the molecules of the gas would strike the projectile with a mean velocity of about 12,500 feet-seconds. You will observe I say mean velocity, and you must note that the molecules move with very variable velocities. Clerk Maxwell was the first to calculate the probable distribution of the velocities. A little more than one-half will have the mean velocity or less, and about 98 per cent. will have 25,000 feet-seconds or less. A very few, about one in 100 millions, might reach the velocity of 50,000 feet-seconds.

The mean energy of the molecules of different gases at the same temperature being equal, it is easy from the data I have given to calculate the mean velocity of the molecules of the slowest moving gas, carbonic anhydride, which would be about 2600 foot-seconds.

I have detained you, I fear, rather long over these figures, but I have done so because I think they throw some light upon the extraordinary violence that some explosives exhibit when detonated. Take, for instance, the lyddite shell exploded by detonation I showed you earlier in the evening. I calculate that that charge was converted into gas in less than the 1/60,000th part of a second, and it is not difficult to conceive the effect that these gases of very high density suddenly generated, the molecules of which are moving with the velocities I have indicated, would have upon the shell.

The difference between the explosion of gunpowder fired in a close vessel, and that of gun-cotton or lyddite when detonated, is very striking. The former explosion is noiseless, or nearly so. The latter, even when placed in a bag, gives rise to an exceedingly sharp metallic ring, as if the vessel were struck a sharp blow with a steel hammer.

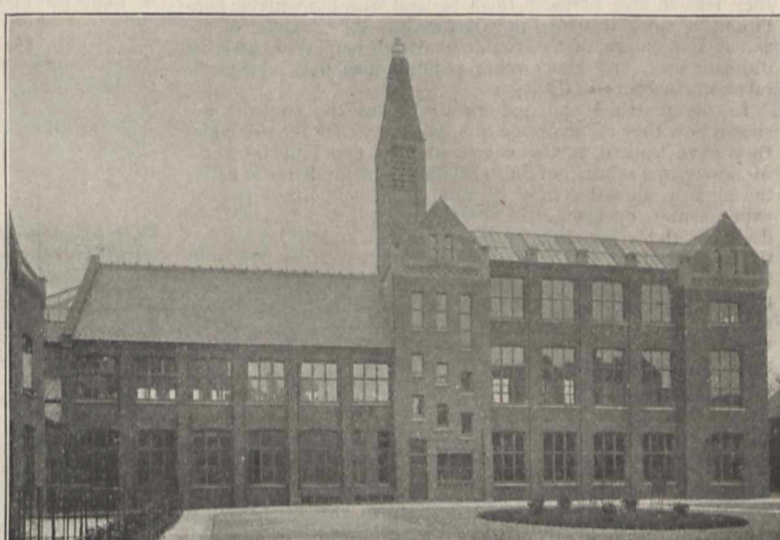
But I must conclude. I began my lecture by recalling some of the investigations I described in this place a great many years ago. I fear I must conclude in much the same way as I then did, by thanking you for the attention with which you have listened to a somewhat dry subject, and by regretting that the heavy calls made on my time during the last few months have prevented my making the lecture more worthy of my subject and of my audience.

EXTENSIONS OF THE DYEING DEPARTMENT OF YORKSHIRE COLLEGE.

THE opening of the extensions in the Clothworkers' Departments of Yorkshire College, Leeds, has already been referred to (p. 69). The new buildings, which are shown in the accompanying illustration, comprise practical and pattern dyehouses and a research laboratory; and, as with several other parts of Yorkshire College, they owe their erection to the generous interest taken in technical education by the Clothworkers' Company of London.

The Clothworkers' Departments of the Yorkshire College consist of textile industries, dyeing and art. The buildings occupied by these departments have been erected by the Clothworkers' Company at a cost of about 60,000*l.*; they are spread over an area of about one-and-a-half acres, and have been specially arranged and equipped for the teaching of all the subjects connected with the designing and manufacturing of woven fabrics.

The Dyeing Department of the Yorkshire College was established in 1880, and the head of the department is Prof. J. J. Hummel. Although the accommodation at first provided was extremely limited, it nevertheless sufficed to show that a demand for instruction in dyeing really existed, and that a continuous supply of students for this subject was available. In due time it was found desirable to increase the facilities for experimental work, and in 1885 the Clothworkers' Company of London erected and equipped, at an expense of about 12,000*l.*, the front portion of the handsome and commodious building at present occupied.



New Buildings of the Dyeing Department of Yorkshire College.

It was felt some years ago that the work of the different departments might be connected. It was considered desirable, for example, that the coloured yarns employed in the weaving department should be dyed by the students in the dyeing department, so that, if at the same time these yarns could also be manufactured on the premises by the establishment of a spinning department, it would become possible to teach the whole routine of clothworking, from the wool in the raw state to the finished cloth. Acting upon this idea, the Clothworkers' Company decided to make the necessary provision for carrying out the scheme suggested, and to extend both the weaving and dyeing departments, at a cost of about 25,000*l.* In connection with the dyeing department, it was arranged to build a three-storied building, to provide two additional dyehouses in which practical dyeing could be carried on, and also a research laboratory for the prosecution of scientific investigations connected with dyestuffs and dyeing.

In July 1896, the foundation stone of the new Clothworkers' Research Laboratory and the other extensions was laid by the

Master of the Clothworkers' Company, and the completed buildings were opened on May 11.

At the present time, therefore, the dyeing department of the Yorkshire College is represented by a building of considerable dimensions, and so comprehensive in character and equipment as practically to meet every requirement for the purpose of giving a complete theoretical and practical instruction in the art of dyeing in all its branches.

Some idea of the magnitude of the work done in the dyeing department of Yorkshire College may be gained from the fact that each session over 200,000 dyed patterns are distributed. Each student, according to the time spent in the dyehouse, receives during his course of instruction from 2000 to 20,000 patterns, each of which conveys a definite piece of information on some point connected with the application of this or that colouring matter. Not only is the behaviour in the dyebath of each colouring matter investigated, but notes of the results obtained are made by the students during the progress of the work. Further, each student enters in his own book all the patterns received, together with notes of the materials employed, and the results of each experiment. Hence the students not only learn how to experiment and discover the capabilities of each colouring matter for themselves, but they also acquire the useful habit of observing and of making notes, while their pattern books contain a fund of information which is invaluable to them in their after career. The systematic training which they receive also prepares them to deal with the variable conditions of work in actual practice, such as the character of the water, the nature of the textile material employed and its ultimate uses, and many other points which must always be taken into account in dyeing.

In the practical and pattern dyehouses the students are shown how they are expected to apply in practice the principles they have learned in the course of their experimental work. Moreover, the solution of difficulties which naturally arise under the slightly altered conditions from those obtaining in the experimental dyehouse, the greater confidence inspired by dealing with the larger quantities of material, and the knowledge that the products of their labour are really to be employed in the manufacture of cloth, are all factors of inestimable value in the training of the students before they enter into actual practice, to which they are as it were brought indeed one step nearer by the character of the work pursued. Altogether, the students are able, in the College dyehouses, to gain at least some insight as to the meaning and value of practical experience, and an influence is exerted which reacts by giving life and vigour to the work of the whole department.

The art of dyeing owes much to science, and in a University College like the Yorkshire College, it is not unreasonable to expect that students of the art should, in return, contribute something to science, more particularly to that branch of it which pertains to dyeing. If in the experimental and practical dyehouses the students are taught the *art* of dyeing, in the Clothworkers' Research Laboratory they are also urged to study the *science* of dyeing. The aim here is to assist in the work of gaining a fuller and truer knowledge of the fundamental laws and principles connected with dyestuffs and dyeing, and so help to raise, as far as possible, the whole tone and level of the dyeing trade, by infusing into it the traits of an exact science. The carrying on of original research by advanced students has already become, indeed, a marked feature of the department, and the Clothworkers' Company have, in a special way, recognised the value of such work by establishing a lectureship, the holder of which devotes his whole time to co-operating with the professor in introducing students to this higher form of study.

This research work, too, has an intimate connection with Prof. Hummel's lectures, in the course of which are described the methods employed in preparing the coal-tar colours, in isolating the pure colouring principles of dyewoods, and in studying the chemistry of mordanting, dyeing, &c. By allowing the students to carry out similar experiments themselves, the College enables them to understand, in a clearer manner than is otherwise possible, how our knowledge concerning dyestuffs and dyeing has been acquired, and it is hoped that by reason of the practical experience thus gained in the art of research, some students may, in due time, become independent investigators.

The Clothworkers' Research Laboratory is an addition which gives completeness to the means of instruction in dyeing already furnished. The advanced students are thereby provided with the facilities for extending the boundaries of science connected with dyeing, and it is hoped that many young men will take advantage of the opportunity thus given. If in the pursuit of this object the authorities at Yorkshire College can succeed in attracting and training a band of earnest workers; if a well-recognised and successful School of Research in Dyeing is established, side by side with the School of Practical Dyeing, it cannot but be of inestimable value from an educational as well as from a practical point of view, for, if the students, before they leave the College, are taught to contribute to the general sum of knowledge it it surely education in the truest and best sense of the term.

MR. NIKOLA TESLA'S RECENT ELECTRICAL EXPERIMENTS.

A REMARKABLE paper, by Mr. Nikola Tesla, appears in the June number of the *Century Magazine*. The subject is "The Problem of Increasing Human Energy, with Special Reference to the Harnessing of the Sun's Energy"; and though metaphysical and sociological questions receive a large share of attention, the article contains an account of some very interesting electrical experiments, now described for the first time, illustrated by several very striking photographs, two of which are here reproduced. Mr. Tesla has been engaged for several years in further investigating the properties of alternate currents of high potential and frequency, with which he astonished audiences at the Royal Institution in 1892 (see NATURE, vol. xlv. p. 345). The following abstract of a part of his paper shows that his work has led to results of scientific interest and significance.

Electrical discharges capable of making atmospheric nitrogen combine with oxygen have recently been produced. Experiments made since 1891 showed that the chemical activity

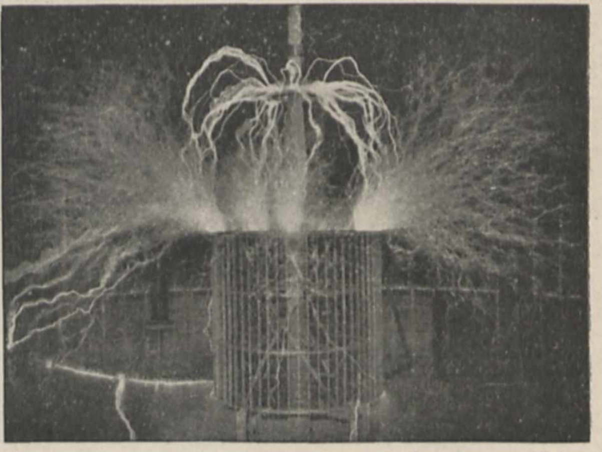


FIG. 1.—Combustion of atmospheric ni rogen by the discharge of an electrical oscillator giving twelve million volts and alternating 100,000 times per second. The flame-like discharge shown in the photograph measured 65 feet across.

of the electrical discharge was very considerably increased by using currents of extremely high frequency or rate of vibration. This was an important improvement, but practical considerations soon set a definite limit to the progress in this direction. Next, the effects of the electrical pressure of the current impulses, of their wave-form and other characteristic features, were investigated. Then the influence of the atmospheric pressure and temperature and of the presence of water and other bodies was studied, and thus the best conditions for causing the most intense chemical action of the discharge and securing the highest efficiency of the process were gradually ascertained. The flame grew larger and larger, and its oxidising action more and more intense. From an insignificant brush-discharge a few inches long it developed into a marvellous electrical phenomenon, a roaring blaze, devouring the nitrogen of the atmosphere and measuring sixty or seventy feet across (Fig. 1). The flame-like discharge visible is produced by the intense electrical oscillations which pass through the coil shown, and violently agitate the electrified molecules of the air. By this means a strong affinity is created between the two normally indifferent constituents of the atmosphere, and they combine readily, even if no further provision is made for intensifying the chemical action of the discharge.

Under certain conditions the atmosphere, which is normally a high insulator, assumes conducting properties, and so becomes capable of conveying any amount of electrical energy. The discovery of the conducting properties of the air, though unexpected, was only a natural result of experiments in a special field carried on for some years previously. It was during 1889 that certain possibilities, offered by extremely rapid electrical oscillations, led to the design of a number of special machines adapted for their investigation. One of the earliest observations made with these new machines was that electrical oscillations of an extremely high rate act in an extraordinary manner upon the human organism. Thus, for instance, powerful electrical discharges of several hundred thousand volts, which at that time were considered absolutely deadly, could be passed through the body without inconvenience or hurtful consequences. Another observation was that by means of such oscillations light could be produced in a novel and more economical manner, which promised to lead to an ideal system of electric illumination by vacuum-tubes, dispensing with the necessity of renewal of lamps or incandescent filaments, and possibly also with the use of wires in the interior of buildings.

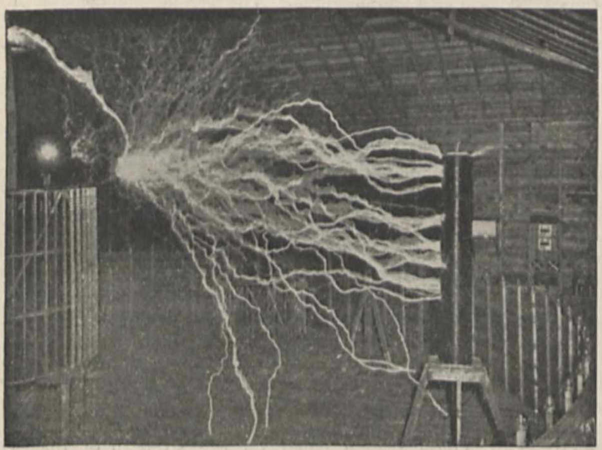


FIG. 2.—The coil, partly shown in the photograph, creates an alternating current of electricity at the rate of 100,000 alternations per second. The discharge escapes with a deafening noise, striking an unconnected coil 22 feet away, and creating such an electrical disturbance that sparks an inch long can be drawn from a water-main at a distance of 300 feet from the laboratory.

The investigations led to other valuable observations and results, one of the more important of which was the demonstration of the practicability of supplying electrical energy through one wire without return. To what a degree the appliances have been perfected since the demonstrations in 1892, when the apparatus was barely capable of lighting one lamp, will appear from the fact that as many as four or five hundred lamps have been lighted in this manner.

The success of this method of transmission suggested that the earth could be used as a conductor, thus dispensing with wires. The earth was regarded as an immense reservoir of electricity, which could be disturbed effectively by a properly designed electrical machine. Accordingly efforts were directed toward perfecting a special apparatus which would be highly effective in creating a disturbance of electricity in the earth, and a novel kind of transformer or induction-coil, particularly suited for this special purpose, was designed. By means of this apparatus, it is practicable, not only to transmit minute amounts of electrical energy for operating delicate electrical devices, but also electrical energy in appreciable quantities.

However extraordinary the results exemplified by Fig. 2 may appear, they are but trifling compared with those which are attainable by apparatus designed on these same principles. Electrical discharges have been produced, the actual path of which, from end to end, was probably more than one hundred feet long; but it would not be difficult to reach lengths one hundred times as great. Electrical movements occurring at the rate of approximately one hundred thousand horse-power have been obtained, but rates of one, five, or ten million horse-power are easily practicable.

The most valuable observation made in the course of these investigations was the extraordinary behaviour of the atmosphere toward electric impulses of excessive electromotive force. The experiments showed that the air at the ordinary pressure became distinctly conducting, and this opened up the wonderful prospect of transmitting large amounts of electrical energy for industrial purposes to great distances without wires, a possibility which, up to that time, was thought of only as a scientific dream. Further investigation revealed the important fact that the conductivity imparted to the air by these electrical impulses of many millions of volts increased very rapidly with the degree of rarefaction, so that air strata at very moderate altitudes, which are easily accessible, offer, to all experimental evidence, a perfect conducting path, better than a copper wire, for currents of this character.

The experiments have indicated that, with two terminals maintained at an elevation of not more than thirty thousand to thirty-five thousand feet above sea-level, and with an electrical pressure of fifteen to twenty million volts, the energy of thousands of horse-power can be transmitted over distances which may be hundreds and, if necessary, thousands of miles. Investigations are now being carried on with the object of reducing considerably the height of the terminals now required.

SOME SCIENTIFIC ASPECTS OF TRADE.

A REPORT on the trade and commerce of Leghorn, for the year 1899, by Mr. Vice-Consul Carmichael, has just been received at the Foreign Office and published as No. 2714 of the Annual Series. The following extracts from the report are of interest as showing the various points at which scientific work and knowledge touch industry.

The proportion of sulphate of copper imported from Great Britain in 1898 was 96 per cent.; it had in 1899 fallen to 76 per cent. The explanation of this unwelcome fact appears to be due to keen United States competition. Italian manufacture is likely to become an even more formidable danger in the near future. Manufacturers appear as a rule to have gone to England for the greater part of the raw material, and that of itself was a handicap. Now, however, the flourishing and influential Società Metallurgica of Leghorn is busily erecting the necessary plant for the manufacture of sulphate of copper on a large scale. Italy produces some 26,000 tons of copper annually, and it is said that the company can depend upon securing its material at home. Should this be the case it will at once be seen how formidable a competitor is entering the field. In any case the more satisfactory days of the English trade in sulphate seem to be over.

As this series of reports is yearly obtaining a larger circulation it may perhaps be necessary to state that the wood from which briar pipes are made is not the root of the briar rose, but the root of the large heath known in botany as the *Erica arborea*. Our "briar" is but a corruption of the French "bruyère." The briar-root industry has had a somewhat curious history. First begun in the Pyrenees some 50 years ago, it travelled along the French Riviera and the Ligurian coast (taking Corsica by the way) to the Tuscan Maremma, and has now reached Calabria in the south, which is at present its most flourishing centre. By the very nature of the business, when a certain district has been exhausted of all its roots, the industry must come to an end there, and I have heard the opinion expressed that the Italian branch of it cannot last much more than another ten years. Leghorn has always been the centre of the export of Tuscan briar-root since the Maremma industry came into existence, but as the South Italian briar is of admittedly superior quality, a large quantity of the Calabrian root is also imported into Leghorn for selection and subsequent export.

The olive oil crop throughout Tuscany, small as it promised to be, has, I regret to say, been more than half destroyed by the ravages of the olive fly. Hence the quantity of olive oil obtained this season in Tuscany has been insignificant, while the quality of most of it is distinctly inferior. A full crop of olive oil may be reckoned at a money value of some 10,000,000*l*.

The olive maggot—which subsequently develops into the olive fly—destroys the pulp of the fruit, and so potent are the ravages of this pest that it is capable of diminishing the yield of oil by one-half, and seriously injuring the quality of the remainder. It will therefore be seen that the fly may actually cause damage in one year amounting to 5,000,000*l*. Notwithstanding the urgency of the matter, no means of destroying the insect appear so far to have been discovered, nor has the State suggested any practical remedy. The subject is recommended to the notice of English men of science, as any discovery which should exterminate the plague ought certainly to be profitable. What seems to be wanted is that entomologists of experience should carefully study the habits of the fly with a view to finding out the hitherto undiscovered winter habitat. Then alone could proper steps be taken for its destruction. It has been hazarded with some likelihood that the winter habitat of the fly must be in the bark of the olive trees. If that were the case, all that would be needed would be to paint the trees during the winter with a simple solution of lime, which, though it might spoil the beauty of the Italian landscape, would rid the country of a very formidable enemy to its agricultural prosperity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Two University lectureships in experimental physics are now vacant. The appointment is for five years, and the stipend 50*l*. a year. Applications should reach the Vice-Chancellor by June 2.

The researches of Mr. L. N. G. Filon, advanced student, of King's College, in relation to certain problems in applied mechanics, have been approved as a qualification for the B.A. degree.

Sixty-three men and nineteen women have acquitted themselves so as to deserve honours in the Mathematical Tripos, Part I.

Honorary degrees will, on June 12, be conferred on the Earl of Rosse, F.R.S., Sir Benjamin Baker, F.R.S., Sir W. L. Buller, F.R.S., Prof. S. P. Langley, Prof. W. M. Flinders Petrie and Prof. H. Poincaré.

The graces for the establishment of a new special examination in agricultural science for the B.A. degree was opposed on May 24, but it was carried by a large majority. The first examination will take place at the end of the year.

ONE of the chief difficulties which has to be overcome by Technical Education Committees is the defective character of elementary education, respecting which lament is very general. Several instances of this difficulty are given in the current number of the *Record of Technical and Secondary Education*. The Durham committee have been compelled for some years to give financial assistance to preparatory classes now formed in all but twenty-one districts of the county. The committee have by such means paved the way for their new regulation of 1899 that there must be "the production of evidence of preparatory training on the part of all new applicants on whom attendance grants would be claimed." This action already appears to be having a satisfactory effect. The Cambridgeshire, Nottinghamshire and Staffordshire committees also deal at some length with the question of defective elementary education. The Cambridgeshire committee go so far as to say:—"The very backward state of elementary education has made it extremely difficult, if not impossible, to establish a system of technical education in the proper sense of the term." The Staffordshire committee speak of it in its relation to "the early age at which pupils leave the elementary schools," and this has thrown upon them "much elementary and preparatory work which otherwise would have been unnecessary." The importance of promoting the efficiency of the work of evening continuation schools cannot be too strongly urged, as they largely constitute the foundation of the work of Technical Education Committees and thus lead on to higher and specialised instruction.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, May 25.—Prof. J. D. Everett, F.R.S., Vice-President, in the chair.—Prof. S. P. Thompson showed some experiments illustrating the aberration called Coma. If a converging lens is placed obliquely in a parallel beam of light, instead of giving a point image, it produces unilateral distortion, and the bright central spot is accompanied by a pear-shaped tail, which is known as a coma. The direction in which this tail points depends upon the side of the lens which is presented to the light. With a concavo-convex lens the convex surface gives an inward pointing coma, and the concave surface an outward pointing coma. The existence of this phenomenon is due to unequal magnification from different zones of the lens, a fact which was shown by covering the lens with a zone-plate of three or four rings and viewing on a screen the distorted images of the several zones. The form of a coma varies greatly with the distance of the screen from the lens. A parallel beam of light which has passed obliquely through a convex lens is capable of producing some curious shadows. The shadow of a rod can be obtained as a circular spot, and that of a grating, made by stretching threads between two rods, as concentric circular rings. Prof. Thompson also showed a stringed model illustrating the paths of light-rays in the formation of a coma. —Mr. R. T. Glazebrook then read some notes on the measurement of some standard resistances. Three methods have been employed by the author for building up multiples of a standard resistance, such as a one-ohm coil. The first method consists in making as accurately as possible three three-ohm coils. These in parallel can be compared directly with the standard by Carey Foster's method. Their resistance in series is very approximately nine times that in parallel, and hence an accurate determination of a resistance about nine ohms can be obtained. If, then, this resistance is put in series with the standard, an accurately-known ten-ohm resistance is obtained. By a similar process, a hundred- or a thousand-ohm coil can be built up. The second method consists in calibrating a resistance-box. The one-ohm coils of the box are compared directly with the standard, and the other resistances determined accurately by a building-up process, using a subsidiary resistance-box. In comparing the high resistances, the difference between the two boxes may be so great as to send the balance off the bridge wire. In these cases the third method is employed. The equal arms of the bridge are accurately known, and one of them is shunted with a resistance, which need not be accurately known, until the reading is brought back on to the wire. The coils chiefly used throughout the experiments are made of platinum-silver. —Mr. J. J. Guest read a paper on the strength of ductile materials under combined stresses. The author throughout his experiments has used the "yield point" of a material as the true criterion of its strength, and has rejected the elastic limit as being modified by local yielding. At present, two theories are used in the calculation of strengths of materials. The first is that the material yields when one of the principal stresses reaches a certain amount. This theory, which was adopted by Rankine and is used by engineers in England and America, is not in accord with recent experiments. The second theory is that the material yields when the greatest strain reaches a certain amount. This was advocated by St. Venant, and is used by engineers on the Continent. Besides these there is a third theory of elastic strength, in which the condition of yielding is the existence of a shearing stress of a specific amount. In the case of a solid bar subjected to torsion, there is a variation in the strain from the axis outwards, and consequently the materials have been used in the form of thin tubes. This allows the application of an internal fluid pressure. The specimens were of steel, copper and brass, the state of set caused by drawing having been removed by annealing. The tubes were subjected to (1) torque, (2) torque and tension, (3) tension only, (4) tension and internal pressure, (5) torsion and internal pressure, and (6) internal pressure only. The axial elongation, the twist, and occasionally the circumferential strain were measured. Towards the end of the experiments observations were made on bending. The results disprove the maximum stress theory, and are at variance with the maximum strain theory. The maximum shearing stress developed, and the corresponding shearing strain were comparatively constant throughout the experiments, and no other simple relation between the stresses or strains was even approximately constant. The results of the experiments have been plotted synoptically on a curve, and the several lines have been drawn upon which these points should lie, according to the various theories. It is readily seen that the points cluster round the line which represents the existence of a specific shearing stress. The author, therefore, favours the existence of this stress for any material. The chairman read a communication upon the subject from Dr. Chree. Mr. Guest, in his paper, has regarded the shearing stress theory as a little known one. As the shearing stress is half the difference between the greatest and least principal stresses, this theory is the same as Prof. G. H. Darwin's maximum stress-difference theory. All the theories suppose that the stress-strain law is linear, and that strains are so small that their squares and products can be neglected. Mr. Guest concludes that in ordinary materials the law is linear to the elastic limit, which answers to a stress lower than that which answers to the yield point, and that yield point phenomena arise between these. Nevertheless, he focusses attention on the yield point as the criterion of strength, and assumes that Hooke's law holds up to it.

Entomological Society, May 2.—Mr. W. L. Distant, Vice-President, in the chair.—Mr. W. L. Distant exhibited the cocoon, measuring nearly three and a half inches each way, of a Coprid beetle—probably belonging to the genus *Heliocopris*—found at Pretoria in the Transvaal.—The Rev. Theodore Wood exhibited a specimen of *Carabus auratus*, L., taken in either June or September 1898 by Mr. Ferrand, of Littlefield House, Exmouth, on the Haldon Hills in the neighbourhood of that town.—Mr. McLachlan exhibited an example of *Rhinocyphea fulgidipennis*, Guérin, a brilliant little dragon-fly of the subfamily *Calopteryginae*, a native of Cochin China, which, so far as he knew, had not been captured since prior to 1830. It had been in M. Guérin's hands, and Mr. McLachlan had received it from M. René Oberthür.—Mr. T. A. Chapman exhibited various specimens illustrating *Acanthopsyche opacella*.—Mr. Barrett exhibited specimens of Heterocera destructive to the fruit crops of South Africa. Among them *Sphingomorpha monteironis*, Butl., known as the Fruit Moth in Cape Colony—a bold and powerful insect, with a sucking tongue strong enough to pierce the sound skin of a peach or fig. The presence of a light does not appear to disturb it, so that examination of its methods can be readily made, when it can be seen that it does not take advantage of the natural opening into a fig, or of a crack or other injury to a peach, but deliberately pierces a hole which afterwards shows as a small round spot, from which decay invariably results. It seems a matter of indifference to the moth whether the fruit has fallen, or is on the tree, ripe or unripe. With regard to *Achaea lienardi* and *Serrodes inara*, the two species are restless and timid, and therefore more difficult to observe. In the present season, however, both have been extremely abundant, and have been seen at apparently uninjured fruit, so that it seems they are capable of equal destruction. Several others, feeding mainly on damaged fruit, were also taken with the aforesaid species, among them some new to science, and recently described by Sir George Hampson. Mr. Jacoby exhibited *Callomorpha wahlbergi* from Africa, and *Spilopyra sumptuosa* from Australia.—A paper was communicated on "New Palæarctic Pyralidæ," by Sir George F. Hampson, Bart.

Anthropological Institute, May 15.—Mr. C. H. Read, President, in the chair.—The president alluded to the severe loss which the Institute and anthropology in general had sustained in the loss of its former president, the late General Pitt-Rivers.—Mr. F. Haverfield contributed a note on certain stone objects discovered on a Roman site at Clanville, in Hants, and a discussion ensued from which it appeared improbable that they were of human workmanship.—Mr. J. Allen Brown described a collection of stone implements brought from Pitcairn Island by Lieut. Pike, R.N. The implements are of two types, both formed of the volcanic rocks of the island. The first series consists of stone axes of analogous forms to those of other islands of the Pacific. The other is peculiar, being large, and with incurved sides and broad cutting edge, more or less ground as well as chipped. A third form is that of a cylindrical chisel. The author mentioned also the discovery of rock carvings of sun, moon, birds, &c., tombs with pottery and human skulls, and of carved stone figures like those of Easter Island. The fact that the implements were found below the surface of the ground, and that from the time of its discovery by Carteret until its occupation by the mutineers of the *Bounty*, makes it probable that the remains in question are of considerable age.—Mr. H. Stopes exhibited a number of unclassified stone objects which he had collected from the river gravels of the Thames valley, and discussed the purposes for which he believed them to have been shaped. He also produced specimens of *Neritina fluviatilis* found in the same gravels, which he regarded as an indication of their age.

Zoological Society, May 22.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—A communication was read from Prof. G. B. Howes, F.R.S., and Mr. H. H. Swinnerton, on the development of the skeleton of the Tuatera, *Sphenodon* (*Hatteria*) *punctatus*, which was stated to be the outcome of eighteen months' work on materials supplied to the authors by Prof. Dendy, of Christchurch, N.Z. An account was given of the egg, the hatching, and the habits of the hatched young, which the authors reared till four months old.—The Malacostracan Crustacea collected by Mr. Rupert Vallentin at the Falkland Islands, from December 1898 to February 1899, formed the subject of a paper by the Rev. T. R. R. Stebbing, F.R.S. Many of the species had long been known, as several scientific expeditions had been made to these islands during this century. This carefully made collection, however, had afforded a much needed opportunity for discussing and clearing up obscure points in some of the earlier descriptions of the Crustacean fauna.—Mr. L. A. Borradaile read the fourth instalment of his memoir on Crustaceans from the South Pacific. This part contained an account of the crabs, of which 77 species were enumerated. Seven new species were described, and a scheme of classification of the swimming crabs (*Portunidae*) was put forward.—A communication was read from Dr. R. Bowdler Sharpe, which contained an enumeration of the birds—56 species in all—collected during the Mackinder Expedition to Mount Kenya, accompanied by field-notes of the collectors.—Mr. F. E. Beddard, F.R.S., read a paper, entitled "A Revision of the Earthworm Genus *Amyntas*." According to the author, this genus comprised 102 species, which were enumerated and commented upon.—Mr. Beddard also read a paper on the structure of a new species of earthworm, which he proposed to name *Benhamia budgetti*, after its discoverer, Mr. J. S. Budgett, who had obtained two specimens of it at M'Carthy's Island during his recent visit to the Gambia.

PARIS.

Academy of Sciences, May 21.—M. Maurice Lévy in the chair.—Researches on the formation of nitric acid during combustions, by M. Berthelot. The compressed oxygen used in combustions in the calorimetric bomb always contains a small quantity of nitrogen, up to 8 per cent. A portion of this is oxidised during the combustion, and the amount of nitric acid so formed has been regularly measured in order to correct the calorimetric data. The author now attempts to trace the relation between the nature of the organic substance under combustion and the quantity of nitric acid formed, details being given in the present paper of experiments on amorphous carbon, graphite and diamond.—Limits of combustibility by red-hot copper oxide of hydrogen and methane diluted with large volumes of air, by M. Armand Gautier. When combustible gases, such as hydrogen or marsh gas, are mixed with large quantities of air and are passed over columns of red-hot copper oxide, the difficulty of completely burning the gas increases with the dilution. Thus with a dilution of 20 parts in 100,000, hydrogen is not completely burnt on passing over a column of 35 centimetres of red-hot copper oxide, but combustion is complete when this length is doubled. Methane is more difficult to burn; thus at a dilution of 7 in 100,000 nearly half the carbon escaped unburnt after passing over a column of oxide 70 cm. long.—Publications of the Observatory of Besançon from 1886 to 1896, by M. Lœwy.—Action of hydrogen bromide upon dextro-rotatory benzylidene camphor, by MM. A. Haller and J. Minguin. Benzylidene camphor combines with hydrobromic acid to form mono-bromo-benzyl-camphor. If the combination is carried out at 100°, two other products are obtained, benzylidene-campholic acid,

$$(COOH).C_8H_{14}.CH{:}CH.C_6H_5,$$

and phenyloxy-homocampholic acid,

$$(COOH).C_8H_{14}.CH_2.CH(OH)C_6H_5,$$

derivatives of which are described.—On fossil forests and the vegetative soils of the coal-measures, by M. Grand'Eury. Further arguments in favour of the author's view that the vegetable fossils have really grown in the places where they now occur, and have not been deposited there by water.—

Report on works presented by M. Marx.—Remarks on an eruption of the volcano Mayon in the Isle of Lucon, by the French Consul for the Philippines.—On the convergence of the coefficients in the development of the perturbation function, by M. A. Férand.—Remarks on a memoir of M. Massau on the graphical integration of some partial differential equations, by M. J. Coulon.—On a remarkable point in relation with the Joule-Thomson effect, by M. Daniel Berthelot. The point at which the inversion of the Joule-Thomson effect occurs is deduced by a graphical construction from the data of Amagat, and the result compared with some recent calculations of M. Van der Waals.—On the distribution of currents and potentials in the periodic state set up in the length of a symmetrical polyphase line presenting capacity, by M. Ch. Eug. Guye.—On resonance in wireless telegraphy, by M. A. Blondel. —Communication by wireless telegraphy with the aid of radio-conductors with polarised electrodes, by M. C. Tissot.—On anhydrous calcium dioxide and the constitution of its hydrates, by M. de Forcand. A thermochemical paper.—On some properties of aluminium, and on the preparation of gaseous hydrogen phosphide, by M. Camille Matignon. Details are given showing how to burn aluminium in steam, carbon monoxide and dioxide, oxides of nitrogen, formic acid, sulphur dioxide and other gases and vapours. The preparation of crystallised aluminium phosphide is described, from which pure PH_3 can be readily obtained.—Combinations of lithium bromide with ammonia, by M. J. Bonnefoi.—The compounds $LiBr.NH_3$, $LiBr.2NH_3$, $LiBr.3NH_3$, $LiBr.4NH_3$ are indicated by a study of the dissociation pressures. The application of the Clapyron formula to these data gives values for the heats of dissociation of these compounds in good agreement with the direct thermochemical measurements.—On two polysulphides of lead and copper, by M. F. Bodroux. The compounds PhS_5 and Cu_2S_5 are described.—On a mercury chlorosulphide, by M. F. Bodroux. A chlorosulphide, $Hg_2S_5.HgCl_2$, can be prepared, which is stable at ordinary temperatures.—Action of water upon mercurous sulphate, by M. Gouy.—Partial synthesis of lævo-rotatory erythritol, by M. L. Maquenne. Wohl's method is applied to xylose, the steps being xylosoxime, acetylxylonic nitrile, erythose-acetamide, and erythrite.—Preparation of the dialkylamido-dichloranthraquinones, by M. E. C. Severin.—On a monoiodohydrin of glycol, by MM. E. Charon and Paix-Séailles.—On γ-chlorocrotonic acid, by M. R. Lespieau. A description of the properties of $CH_2Cl.CH:CH.CO_2H$, its nitrile and ethyl ester.—On the composition of the albumen of the St. Ignatius bean and of the *nux vomica* bean, by MM. Em. Bourquelot and J. Laurent. The albumen from these beans yields the same carbohydrates, a mixture of a mannane and a galactane, as the albumen of leguminous beans previously studied. In *nux vomica* the proportion of galatose found on hydrolysis is very high. These beans, in fact, serve as an advantageous source of crystallised galatose. —Experimental researches upon the evolution of the lamprey, by M. E. Bataillon.—Remarks upon certain points in the life-history of the lower organisms, by M. J. Kunstler.—On some new Synclavellæ in the compound Ascidians, by M. Maurice Caullery.—Analysis of marine deposits collected off Brest, by M. J. Thoulet.—The mineral matters in the human fœtus during the last five months of pregnancy, by M. L. Hugonenq. —Identity of a bacillus from milk with the pneumobacillus of Friedlænder, by MM. L. Grimbert and G. Legros. The complete identity of these bacilli was shown by a comparative study of their general biology and morphology, and of their action upon carbohydrates.

DIARY OF SOCIETIES.

THURSDAY, MAY 31.

ROYAL SOCIETY, at 4.30.—Palæolithic Man in Africa: Sir John Evans, F.R.S.—On the Estimation of the Luminosity of Coloured Surfaces used for Colour Discs: Sir W. de W. Abney, F.R.S.—The Sensitiveness of Silver and of some other Metals to Light: Major-General Waterhouse.—The Crystalline Structure of Metals (Second Paper): Prof. Ewing, F.R.S., and W. Rosenhain.—Vapour-density of Bromine at High Temperatures (Supplementary Note): Dr. E. P. Perman and G. A. S. Atkinson.

FRIDAY, JUNE 1.

ROYAL INSTITUTION, at 9.—Bunsen: Sir Henry Roscoe, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—Our Older Sea Margins: Sir Archibald Geikie, F.R.S.

TUESDAY, JUNE 5.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—The Metric System of Identification used in Great Britain: Dr. J. G. Garson.

WEDNESDAY, JUNE 6.

GEOLOGICAL SOCIETY, at 8.—Mechanically-formed Limestones from Junagadh and other Localities: Dr. J. W. Evans.—Note on the Consolidated Æolian Sands of Kathiawad: Frederick Chapman.—On Ceylon Rocks and Graphite: A. K. Coomara Swamy.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Determination of Oxygen in Copper by Ignition in Hydrogen: Leonard Archbutt.—Uniformity in the Conduct of Soil Analysis: A. D. Hall.—The Adulteration of Wheaten Flour with Maize: G. Embrey.—A New Colour Reaction for distinguishing between certain Isomeric Allyl and Propenyl Phenols: Alfred C. Chapman.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, JUNE 7.

LINNEAN SOCIETY, at 8.—On a Viviparous Syllid Worm: E. S. Goodrich. —On the Genera Phæoneuron, Gilg., and Dicellandra, Hook f.: Dr. A. Itapf.—On the Structure and Affinities of *Echiurus unicinctus*: Miss Embleton.

CHEMICAL SOCIETY, at 8.—Diphenyl- and Dialphyl-ethylenediamines, their Nitro-derivatives, Nitrates, and Mercurochlorides: W. S. Mills. —Condensation of Ethyl Acetylenedicarboxylate with Bases and β-ketonic Esters: Dr. S. Ruhemann and H. E. Stapleton.—The Constitution of Pilocarpine: Dr. H. A. D. Jowett.—The Nitrogen Chlorides derivable from *m*-Chloroacetanilide and their Transformations: Dr. F. D. Chattaway, Dr. K. J. P. Orton, and W. H. Hurtley.—Derivatives of Cyanocamphor and Homocamphronic Acid: Dr. A. Lapworth.

RÖNTGEN SOCIETY (St. Bartholomew's Hospital), at 8.—Dr. Lewis Jones will show an Influence Machine of American design.—Mr. James Wimshurst, F.R.S., will give a short statement of his work in the design and the perfecting of the several forms of his Influence Machine.—Dr. Rémy, of Paris, will show a new Localising Apparatus.

FRIDAY, JUNE 8.

ROYAL INSTITUTION, at 9.—The Effect of Physical Agents on Bacterial Life: Dr. Allan Macfadyen.

PHYSICAL SOCIETY, at 5.—On the Magnetic Properties of Iron and Aluminium Alloys, Part II.: Dr. S. W. Richardson.—Note on Crystallisation produced in Solid Metal by Pressure: W. Campbell.—On the Viscosity of Mixtures of Liquids and of Solutions: Dr. C. H. Lees.

ROYAL ASTRONOMICAL SOCIETY, at 8.

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