# Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

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VOLUME LXIV

MAY to OCTOBER 1901

*"To the solid ground*
*Of Nature trusts the mind which builds for aye."*—WORDSWORTH



London
MACMILLAN AND CO., LIMITED
NEW YORK: THE MACMILLAN COMPANY

RICHARD CLAY AND SONS, LIMITED,
LONDON AND BUNGAY.

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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THURSDAY, MAY 2, 1901.

## *THE PHYSICIAN AS PHYSIOLOGIST.*

*A Contribution to the Study of the Blood and Blood-pressure.* By George Oliver, M.D. London, F.R.C.P. Pp. xii+276. (London: H. K. Lewis, 1901.) Price 7*s.* 6*d.*

IT is to be feared that most medical men who are engaged in the active practice of their profession have little idea of making a practical application of the knowledge of physiology which they were at so great pains to acquire during the student period of their career. There are, however, many exceptions, and prominent amongst them the author of the little work which it is our present purpose to notice. Dr. George Oliver is fortunate in that his sphere of practice has given him leisure during several months in each year to study at length such physiological problems as have appeared to him to bear more directly upon the affections which he has been mainly called upon to treat, and the result of his studies has been a not immaterial addition to our knowledge of the physiology of the circulation and of the blood. Such addition has been obtained largely by the devising of methods which have more immediate applicability to the human subject than those which are in common use in the physiological laboratory. Not that Dr. Oliver has neglected the more strictly scientific study of physiological questions; as is evidenced by his well-known investigations into the functions of the ductless glands. But in the book before us the methods which are described are solely those which, whilst maintaining a high standard of scientific value, have a direct clinical application, and the observations which are given are the results of such application in the normal and occasionally in the abnormal subject, extending over a period of some ten years.

The first method which is described is that for determining the amount of colouring matter (hæmoglobin) in a sample of blood. For this purpose two chief procedures have come into use clinically. The principle of the one is that of taking a standard solution of hæmoglobin of known dilution and diluting the sample of blood to be tested until its tint is similar to that of the standard (method of Hoppe-Seyler, modified by Gowers by the use of a picrocarmin gelatin, standardised to a known strength of hæmoglobin solution). The other proceeds on the principle of diluting the sample of blood to a constant extent and comparing it with glass tinted to resemble solutions of hæmoglobin of known degrees of dilution (method of Fleischl). In practice this method is the more simple and accurate, and has been adopted by Dr. Oliver, who has, however, for adequate reasons discarded the use of a coloured glass wedge which is the characteristic of Fleischl's hæmometer, and has adopted, instead, a series of coloured glass discs which represent gradations (percentages) in the amount of hæmoglobin of blood as compared with the normal. One of the most important reasons for this modification of the method is of great scientific interest; for it was found by Dr. Oliver, when making observations with Lovibond's tintometer on the mixture of colours required to reproduce exactly the tint of solutions of hæmoglobin of different strengths, that it is not possible to take a glass of a tint the same as that of a fairly strong solution of hæmoglobin and, merely by decreasing its thickness, to imitate the colour of a very weak solution, but that it is necessary, also, to alter the tone of colour with the change in strength of the solution, *e.g.* for comparison with weaker solutions of hæmoglobin it is necessary to add more yellow to the tint of the glass standards which are used for comparison with stronger solutions. The second method described is one for rapidly computing the number of coloured corpuscles in a given sample of blood. The older method depends upon the actual counting of the number in a measured quantity of blood diluted to a known amount with an isotonic solution of salts; indeed, all methods of computation must be standardised by this one. But such computation is laborious and takes some 15 minutes at the very least, whereas by the procedure devised by Dr. Oliver a satisfactory result can be obtained in less than 5 minutes. The method takes advantage of the fact that the coloured corpuscles of the blood impart opacity to any fluid in which they are suspended in sufficient number, and with normal blood taken as the standard a less or greater

percentage of corpuscles than the normal can be at once arrived at with considerable accuracy by determining at what dilution the flame of a candle can be seen through the mixture. By the employment of this method Dr. Oliver has made many determinations of the percentage (as compared with normal) of corpuscles in blood taken under different conditions both in health and disease, the chief of these varying conditions being those relating to time of day, rest and exercise, digestion, temperature and altitude. It is known that the number of red corpuscles per cubic millimetre may rise from 4,500,000 at sea-level to 7,000,000 or 8,000,000 at elevations of from 6000 to 14,000 feet above sea-level. This has been determined by Viault on the Cordilleras and by Egger and others on the Alps, and is confirmed by the author, who finds that the increase is apparent within 24 hours and attains its maximum within the first week. It is, however, not as great as had been supposed; part of the former results depending upon an inaccuracy (at low barometric pressures) in the instrument usually employed for enumeration, an inaccuracy not shared by the cytometer employed in these investigations. The description of these two methods and their results occupies nearly one half of the book, the other half being taken up by a description of methods for investigating the condition of the blood-vessels.

Of these the first is one for determining the average blood-pressure in the arteries. It is based upon the ascertained fact that any instrument which is used to observe the arterial pulse by external application gives the largest indications of pressure variations when the force with which it is itself pressing upon the artery is equivalent to the average blood-pressure within the vessel. This principle has already been employed for gauging the blood-pressure in man by Mosso and others, but the instrument which has been contrived by Dr. Oliver for the purpose, and which he called a "hæmodynamometer," is both more sensitive and more easy of application than most others which have been devised, the pressure being applied to a spring through an india-rubber bag or pad filled with fluid, and the indications being directly read off upon a dial (as in Hill and Barnard's original sphygmoscope). An even more ingenious instrument is the "arteriometer," which directly and with great accuracy measures the calibre of an artery, such as the radial, through all the tissues which cover it. Dr. Oliver has, with the aid of these instruments, recorded a very large number of observations upon the effects upon blood-pressure and upon the arteries of varying physiological conditions such as posture, exercise, emotions, rest and sleep, fatigue, food and digestion, temperature and climate; for the details of these and for many other observations on the effects upon the circulatory system of baths, massage and various other forms of treatment the interested reader is referred to the account which the author has himself given. The book furnishes an excellent illustration of what can be done by the scientific physician for the advancement of physiological knowledge, and its perusal will repay, not only the clinician for whom it is primarily intended, but also the physiologist who desires to compare the results which he obtains by experiments upon animals with those which can be obtained by experiments upon man. E. A. S.

## A GERMAN NATURALIST IN THE WEST INDIES AND AMERICA.

*Von den Antillen zum Fernen Westen; Reiseskizzen eines Naturforschers.* By F. Doflein. Pp. iv + 180. Illustrated. (Jena: G. Fischer, 1900.) Price M. 6.50.

WHILE containing little or nothing in the way of absolute novelty, this narrative of the travels of a German naturalist in the West Indies, Mexico, California, and the far North-West of America is a pleasantly written and charmingly illustrated volume which can scarcely fail to interest and attract a large number of his fellow-countrymen. According to the author, German travellers but seldom visit the countries through which he passed, so that the greater part of what he has to tell will be new to the majority of his readers. With the exception of two, the originals of the photographic illustrations, which add so much to the attractiveness of the volume, were taken by the author himself; and the exquisite manner in which these photographs have been reproduced reflects the highest credit on the firm to whom the task was entrusted.

The first part of the book, which is divided into seven chapters, is devoted to the West Indies, where Martinique was the first island visited. Here the author was much interested in the botanical gardens, where he was struck by the richness of the vegetation, and especially by the luxuriance of the lianas. Several charming views in the island are given.

The author's next point was Barbadoes, where he left the great ocean steamer to take passage in a smaller vessel for a cruise among the lovely isles of the Lesser Antilles group. After devoting several chapters to his experiences among these, the narrator discusses in the sixth the racial problems presented by the West Indies, illustrating a few characteristic types. In Chapter vii. he treats of the fauna of the Lesser Antilles, dwelling on the close connection existing between the animals of that group and those of Venezuela, Colombia and Central America, and giving good pictures of a few of the more remarkable forms, among them the dreaded *fer-de-lance* snake. A section of this chapter describes in some detail the coast fauna of Martinique, a striking feature of this part being the photograph of a tropic-bird in flight.

The remaining nine chapters, forming the second half of the volume, describe the continental portion of the author's tour, and are at least as full of interest as their predecessors. In the first of these chapters (viii.) we have an instructive sketch of the ancient buildings and weapons of Mexico, which the author calls the Pompeii of America. In addition to a view of the celebrated temple of the sun and photographs of stone weapons, the author gives a plate of human and animal clay masks collected by himself at Teotihuacan. In Chapter ix. we have a description of a traverse of the great desert tract of Mexico, illustrated by an excellent photograph of giant cactuses; while, in striking contrast to this, the reader, in Chapter x., is introduced to the glories of a summer's day in California. Following the latter is a description of a Chinese settlement in the same country, where the photograph of "Chinatown" will not fail to impress the reader with the importance assumed by the Mongolian

element in this part of America. Nor is zoology by any means neglected, Chapter xii. being devoted to an account of the Californian marine fauna, illustrated with a photograph of one of the remarkable Pacific hag-fishes of the genus Bdellostoma, and a second of the Californian medusa-starfish. Lovers of forest scenery will be enchanted with the beautiful photograph of a Sequoia-forest in California, which forms the most striking feature in the thirteeenth chapter; this chapter dealing, not only with the primeval forests of the district, but likewise with the timber-felling industry.

In his concluding chapter, Dr. Doflein presents his readers with a capital account of the Yellowstone Park and its animal wonders, illustrating his description with an excellent photograph of a family party of black bears in their native wilds. The photograph of bisons is, however, by no means so successful as it might be, being, for one thing, on much too small a scale. Still more unsatisfactory is the one on page 175 lettered "Die Amerikanische Gemse (Weibchen)," which is intended to portray the female of the pronghuck. If we are not mistaken, the animal in the foreground is a wapiti hind, while the one in the middle distance might be anything.

To any English reader desirous of keeping up his German by the perusal of a pleasantly written narrative of travel, Dr. Doflein's work may be commended; to his own countrymen it will commend itself. R. L.

## A BIBLICAL ENCYCLOPÆDIA.

*Encyclopaedia Biblica, Critical Dictionary of the Literary, Political and Religious History, the Archaeology, Geography and Natural History of the Bible.* Edited by Prof. T. K. Cheyne and Dr. J. Sutherland Black. Vol. ii. E—K. (A. and C. Black, 1901.) Price 20*s.* net.

A WORK like this demands a critic whose forte is omniscience, for the articles are written by men who can speak as authorities, and necessarily enter into questions of theology, a province of human thought with which science is only indirectly concerned. This alone makes it difficult to give any notice of the book in a publication strictly scientific. To read through a volume of 1544 closely printed columns of small type would be a herculean task which we do not pretend to have attempted. We have not perused more than a few of the salient articles in the present volume, which, as it contains the letters from E to K, happens to include a large number of exceptional interest. If we remember that even the letter J covers names such as James, Jasher, Jeremiah, Jerusalem, Jesus, Job, John, Jordan, Joshua, Joseph, Judah and Judges we realise the significance of many articles. These seem to be summaries of everything important that has been written on the subject. Indeed, sometimes the variety is a little bewildering to the ordinary reader, who, however, cannot complain of a stinted choice, though the writers generally favour views distinctly progressive. One or two slips, notwithstanding the care with which, obviously, the work has been done, have caught our eye, such as the statement that the vicinity of Jerusalem consists of strata of the Eocene and *Chalk* formations—where Cretaceous should have been written, as the limestone is not the variety designated chalk; or the obvious clerical error that Esdraelon lies 250 feet *below* the sea-level, which would make it difficult for the river Kishon to reach the Mediterranean. But the topographical articles, which of course have to be largely dealt with from the historical point of view, are generally excellent. For instance, the article "Geography" gives a most interesting account of what was known about that subject by the Old Testament writers. Formerly, no doubt, when the relations of theology and science were ill-understood, questions of Hebrew cosmogony and ethnology were more important than they now are; still there is an antiquarian interest, when the date of a document can be approximately determined, to see how much or how little the Hebrews had ascertained about the rest of the world. Evidently the knowledge of the Old Testament writers hardly extended eastward beyond Persia, or northward so far as the Caucasus, or southward beyond Ethiopia on the African continent, or westward of Greece, excepting Tartessus in Spain or possibly either Sicily or Carthage. If they had any notions of regions lying beyond those limits, such as India or China, these must have been of the vaguest, unless we locate Ophir in Mashonaland, to which identification, however, as we infer from the article on gold, the editor does not incline. The books of the Old Testament cover a long time, and knowledge grew; but we may safely assume that the writer of the ethnographical notices in Genesis x., whatever be their date, either did not know of, or deliberately excluded, the Black and the Yellow races. Probably, indeed, until about the tenth century before our era, the Hebrews had only a very limited knowledge of geography. The article on Egypt is full of information and has been brought down as nearly as possible to date. It is accompanied by three very useful little maps; one, a physical map of the Nile valley, north of Khartoum, another, on a smaller scale, of the Nile and the Euphrates, and a third showing the broader features of the geology. This brings out very clearly the close connection between the Sinaitic peninsula and the mountain region between the river and the Red Sea, and contains much information in a very small space.

A comparison of the historical part of this article with that in Smith's "Dictionary of the Bible," published in 1860, indicates, better than anything, how enormously our knowledge has been increased during recent years. The same is true in regard to the articles on the topography of Jerusalem. No doubt the one in the older work was below the general level, for the editor, owing to some strange infatuation, had accepted as established facts the absurd fancies of the late Mr. James Fergusson. These are properly ignored in the work before us, which treats this difficult and thorny subject in a fair and scholarly fashion. The author may sometimes incline to one view, the reader to another, but evidence is not perverted as it was in the older work. Personally, for instance, we do not believe the Ophel Hill to have been the site of the City of David. The passages supposed to be favourable to this identification are not, in our opinion, of much weight, and the distance of Jebus from any known spring is a difficulty which attaches to many hill forts. Some in our own country could not have endured a close siege for a few days without storage of water, and cisterns were familiar things at Jerusalem.

The western hill, like another Gergovia, is a natural site for a hill fort, while the descending ridge of Ophel, so far as we can infer from our studies of such structures, is exactly the position which their builders would have avoided. Such articles as "Gospels" and "Jesus" introduce us to questions of a character and a theological import which we must not discuss in these columns. Suffice it to say that, while indicating a certain amount of reaction from the extreme vagaries of representatives of the so-called "higher criticism," they express, as a rule, eminently "progressive" views. Some, indeed, are so very advanced that they could not, so far as we can see, be covered by the most liberal interpretation of the Nicene creed. Persons, however, who view with anxiety these removals of ancient landmarks may comfort themselves by observing how many idols of the cave have been set up by one confident discoverer only to be trampled under foot by the next comer. Indeed, on reading some of these efforts of the higher criticism we cannot help being reminded of the famous Historic Doubts, and think that by using similar methods we could prove William the Conqueror to be a person almost mythical and the Battle of Hastings mainly a legend. T. G. B.

## OUR BOOK SHELF.

*Plato's Staat.* F. Schleiermacher. Zweite Auflage. C. Th. Siegert. (1901.) Mk. 3.

*John Locke's Versuch über den Menschlichen Verstand.* Zweiter Band. Zweite Auflage. C. Th. Siegert. (1901.) Mk. 3.

*Berkeley's Abhandlung über die Prinzipien der Menschlichen Erkenntnis.* Dr. F. Ueberweg. Dritte Auflage. (1900.) Mk. 2.

*Berkeley's Drei Dialoge zwischen Hylas und Philonous.* Dr. R. Richter. (Leipzig: Dürr'schen Buchhandlung, 1901.) Mk. 2.

THERE is in Germany a widespread appetite for metaphysics. Earlier there than elsewhere scholars and philosophers of an order not far removed from the highest came to recognise that work bestowed on the translation and elucidation of foreign masterpieces in philosophy was the best of trainings in exact thinking and expression. The zeal of von Kirchmann for his educational ideal was untiring, and his industry was appalling. In the result, the *Philosophische Bibliothek* has succeeded in combining low cost and high achievement. It is the more to be regretted that its volumes so often come to pieces in the hand.

Schleiermacher's translation of "Plato's Republic," with von Kirchmann's sporadic notes, "needs no bush." It will not, of course, be much used in England after the labours of Davies and Vaughan and Dr. Bosanquet. It has undergone some revision, but still scorns Greek accents, while its use of breathings is haphazard. Similarly, von Kirchmann's translation of "Locke's Essay" has undergone revision before reissue. Something of the effect of Locke's style vanishes in the translation, but the substance is there. It is only the separate volume of notes which is likely to interest the English public, and that not greatly. Ueberweg's excellent version of the masterwork of Berkeley's earlier idealism has passed into a third edition, advisedly without revision. Its incisive notes possess some value even for those who have studied their Berkeley with the aids supplied by Prof. Campbell Fraser. It has a worthy successor in Dr. Raoul Richter's translation of "Berkeley's Three Dialogues between Hylas and Philonous." If we have not been singularly unfortunate—or fortunate—in our sampling, Dr. Richter has succeeded as well as the translator of Berkeley could hope to succeed. He adds a straightforward introduction and some luminous notes chiefly on the usage of technical terms. The new series is, to our thinking, superior in form, printing and, above all, in stitching, to the old. The student, for whom the reading of Kant or Hegel in the original is only a hope of the distant future, might be worse advised than to take Dr. Richter's version of the dialogues and ground himself in German philosophical terminology by reading it along with the brilliant original. An English translation of a German "minor masterpiece" at once as excellent as this and as cheap is still to seek.

H. W. B.

*The Fishes of North and Middle America; a Descriptive Catalogue of the Species of Fish-like Vertebrates, found in the Waters of North America, North of the Isthmus of Panama.* By David Starr Jordan and Barton Warren Evermann. Part iv. Pp. ci + 3137-3313; plates I-CCCXCII. (Washington: U. S. National Museum, 1900.)

THE present part concludes this important work, of which we have given a full notice in vol. lxi of NATURE, p. 362. It commences with a systematic arrangement of the fishes described, which serves not only as a table of contents for all the four parts, but also as an exhibition of the views of the authors as to the genetic relations of American fishes. From it it will be seen that the fish-fauna of North and Middle America, as now understood and as stated by the authors, embraces 3 classes, 30 orders, 225 families, 1113 genera, 325 subgenera, 3263 species and 133 subspecies. "Additional Addenda" follow and occupy some 60 pages; they comprise a number of new genera and species described since the publication of part iii., the majority being the result of investigations made by Dr. Jordan in Mexico, and by Dr. Evermann in Porto Rico. Other additions or corrections regarding nomenclature, relations and distribution of previously known species, are duly attended to.

The bulk of the volume is devoted to the illustrations. In this series are represented about 958 types of fishes, thus, so far as numbers are concerned, surpassing even Cuvier and Valenciennes' "Histoire naturelle des Poissons," in which only about 700 species are figured. With few exceptions, the figures are original, and were drawn for the present work from specimens preserved in American collections, and by means of photography reproduced to a uniform size, the width of an octavo page. As the work has been published by the Smithsonian Institution with the view of bringing it within the reach of the people, no highly artistic and, therefore, expensive finish of the illustrations has been attempted; but they have not lost in accuracy thereby, and will fully answer the purpose of assisting the student of ichthyology in his initial studies, or the layman who seeks for occasional information. They show well the general appearance of the fish, the structure of fins and the arrangement of scales; but scarcely any additional details are given to illustrate the characters on which the numerous genera and species distinguished or adopted by the authors are based.

The illustrations are preceded by an explanatory list, in which the names of the artists, the numbers of the original specimens in the United States National Museum, or other sources whence the drawings were derived, are carefully noted. In fact, no pains have been spared by the authors to render their work instructive and handy for reference and ready use.

Already in our first notice we have testified to the high merits of the work; it renders the rich American fish-fauna more accessible than ever before to scientific ichthyologists throughout the world, and cannot fail to give a powerful impetus to the study of fishes in the authors' own country. A. G.

*Die wissenschaftlichen Grundlagen der analytischen Chemie elementar dargestellt.* Von W. Ostwald. Dritte Auflage. Pp. xi+221. (Leipzig: Engelmann, 1901.) Price M. 7.

THE services that Prof. Ostwald has rendered to physical science during the last quarter of a century are so numerous and so valuable that his writings cannot fail to exert considerable influence. In working out and extending the theories of van 't Hoff and Arrhenius he played a leading part in laying the foundations of physical chemistry; and in applying these principles to the consideration of the problems of analytical chemistry, he has effected a complete revolution in the methods of approaching that subject. In 1894 he published the first edition of the "Wissenschaftliche Grundlagen," and thus furnished us with scientific explanations of much that up till that time had been little more than mere empiricism; analytical processes were interpreted by him in the light of the theory of solutions and the ionic hypothesis, and thus new life was infused into a branch of science that had become almost moribund.

It is gratifying to think that Prof. Ostwald's efforts have been appreciated; and the fact that a third edition of this striking work has been called for is sufficient evidence of its success. The new ideas are beginning to take a firm root, and are already finding their way into the latest text-books on the subject.

It is to be hoped that teachers of practical chemistry will study the pages of this last edition of the "Grundlagen der analytischen Chemie," and arrange their methods of instruction on the new lines it suggests. With this end in view Prof. Ostwald has added a chapter containing descriptions of a number of experiments illustrating some of the more important principles on which analytical chemistry is based.

In conclusion, we would draw attention to the closing words in which the author advocates the use of as simple apparatus as possible, that the attention of the student may be concentrated on the chief features of the experiment. Coming from so brilliant an experimenter and so popular a teacher, the advice is worthy of special emphasis.

*An Introduction to Modern Scientific Chemistry.* By Dr. Lassar-Cohn. Translated by M. M. Pattison Muir, M.A. Pp. viii + 348. (London: H. Grevel and Co.)

THE German original of this book has already been noticed in these columns (vol. lxi. p. 51, 1899). It has been translated into smooth English by Mr. Pattison Muir, and it may be cordially recommended as a clear exposition of the leading facts and principles of chemistry, well adapted to the class of readers for whom it was written, namely, University extension students and general readers. It must be borne in mind that the book is not intended for those who are able to study chemistry with their own *hands*. The fifty-eight illustrations in the book are its worst feature, but they are by the author, and no doubt the translator had no choice but to reproduce them. A. S.

*First Aid to the Injured.* By H. Drinkwater. Pp. 104. (London: J. M. Dent and Co.; no date.) Price, 1s. net.

THE number and excellency of the illustrations are special features of this little book, and increase its interest and clearness, doing away also with the need of lengthy explanations. The proportion between the theoretical and practical parts is well maintained. The anatomical details are not by any means unduly prominent, but are only introduced in so far as they are necessary to enable the practical directions to be intelligently followed. The book can be strongly recommended as a clear and trustworthy instruction in "first aid."

## 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.*]

### Solution of Cubic and Biquadratic Equations.

THE historical note in your last number by Sig. Vacca regarding the graphical solution of a cubic, given by Mr. T. Hayashi, reminds me that I had intended, when Mr. G. B. Matthews published his suggestion for the graphical solution of a biquadratic by means of two parabolas (NATURE, Nov. 16, 1899), to point out that he too had been anticipated, as will be seen by referring to a paper by Mr. R. E. Allardice in the *Proceedings* of the Edinburgh Mathematical Society (April 7, 1890), where it is shown that, with the exception of the case where the roots of the biquadratic are equal in pairs, the real roots of the general biquadratic can be found graphically by means of two equal parabolas having their axes at right angles, the one fixed and the other movable; and also that every cubic can be reduced to the form $y^3 \pm y + r = 0$; and then solved graphically by means of the fixed curve $y = x^3$ and the movable straight line $x \pm y = r$.

I may take this opportunity of calling the attention of elementary teachers to the fact, also dwelt upon in Mr. Allardice's paper, that the most convenient method of discussing the algebraic solution of the general biquadratic, and of testing whether any particular biquadratic is soluble by means of quadratics or not, depends on the familiar theorem that $ax^2+2hxy+by^2+2gx+2fy+c$ is decomposable into linear factors if $abc+2fgh-af^2-bg^2-ch^2=0$, and not unless. Along with the biquadratic $x^4+px^3+qx^2+rx+s=0$ (1) consider the equation $x^2-y=0$ (2). By interequational transformation it is obvious that the system (1), (2) is equivalent to the system composed of (2) and $qx^2+pxy+y^2+rx+s=0$ (3). Again, the system (2), (3) is equivalent to the system composed of (2) and $(q-\lambda)x^2+pxy+y^2+rx+\lambda y+s=0$ (4), where $\lambda$ is a constant at our disposal. If $\lambda$ be so chosen that the left hand side of (4) breaks up into linear factors; that is, if $\lambda$ be a root of the cubic

$$\lambda^3-q\lambda^2+(pr-4s)\lambda+4qs-r^2-p^2s=0 \qquad (5),$$

then the system (2), (4) will be equivalent to two systems $y+\mu x+\nu=0$, $y=x^2$, and $y+\rho x+\sigma=0$, $y=x^2$. In other words, the four roots of (1) are the roots of the two quadratics $x^2+\mu x+\nu=0$, $x^2+\rho x+\sigma=0$.

The cubic (5) is not in general soluble by means of quadratics without the adjunction of a cube root: hence the solution of a biquadratic in general depends on the solution of a cubic and two quadratics.

The necessary and sufficient condition that the cubic be soluble by means of quadratics is that it have a commensurable root, which, if it exist, can be readily found by finding an integral root of another cubic of the form $x^3+ax^2+bx+c$, where $a$, $b$, $c$ are all integral. The determination of $\mu$, $\nu$, $\rho$, $\sigma$ then requires, in addition to rational operations with $p$, $q$, $r$, $s$, $\lambda$, merely the extraction of a square root.

To the tyro who is familiar with the elements of the coordinate geometry of the conic sections the rationale of the above process can be made evident by the consideration of the two line-pairs which contain the four points of intersection of two conics. It may be noted that, instead of the parabola $y=x^2$, we may use the rectangular hyperbola $xy=1$, the only difference being that we are led to a different cubic resolvent.

Considering the space usually given in English text-books of algebra to the discussion of equations which are soluble by means of quadratics, it is strange that few, if any, of their authors emphasise the fundamental fact that the reduction of a biquadratic which is soluble by means of quadratics can be effected by finding the rational root of a cubic equation. I fear that I too must plead guilty to this omission, which among other things I propose to make good in the next edition of vol. i. of my "Algebra." G. CHRYSTAL.

Edinburgh, April 26.

### Electro-Chemistry.

ALLOW me to point out an omission unnoticed by your reviewer of Mr. Bertram Blount's book on practical electrochemistry (p. 582). Mr. Blount refers to the electrolysis of gold ore as a failure (Haycraft's method).

The omission is probably due to the fact that the process in question (Riecken's) has not been worked on a large scale except during the last three or four months, though the patent is three years old. Its efficacy depends essentially on securing a clean mercury kathode in the form of a thin stream of mercury flowing over a nearly vertical copper plate.

The liquid containing the pulverised ore is a continually agitated solution of cyanide and the anode is of iron, as the electro-motive force, one and a half volts, liberates nothing more corrosive than cyanogen. The particles of gold are doubtless cleansed of the obstructing sulphide and tellurous films by the convection currents of ionised cyanogen and also, in a more direct way, by the current as it passes through each particle, making in effect one side of it a kathode and the other an anode, just as is seen if we suspend a piece of metal in an electrolyte between the electrodes and unconnected with either.

This simple invention may revolutionise the treatment of refractory ores, yet apparently the inventor could get no hearing for three years till, at his own cost, he erected apparatus on a working scale in West Australia. The facts are valuable as showing how great an interval separates German intelligence from British engineering practice.

Intelligence of any kind, foreign or native, must indeed have been wanting when huge works, regardless of cost, were erected in presence of the published electrolytic method which could have been effectually tested in a single vat.

JOHN HILL TWIGG.

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IF, as your correspondent, Mr. Twigg, says, Riecken's electrolytic process has only been worked on a large scale during the last three or four months, it is not unnatural that Mr. Blount has omitted to describe it. In most cases Mr. Blount has endeavoured to describe processes which are of proved utility, and therefore it was hardly necessary to draw attention to the omission. Further, the number of patents on the subject of electrolytic gold refining is very large, so that it would be manifestly impossible to describe them all. Riecken's process is a very neat one, and should any of the readers of NATURE be interested in the subject, an excellent description is to be found in the "Jahrbuch der Electrochemie" (vol. v. p. 380).

F. MOLLWO PERKIN.

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### Unusual Agitation of the Sea.

ON Wednesday, April 24, on going to the edge of the cliff above Alum Chine, Bournemouth, at 7.50 a.m., I was struck by the appearance of a succession of waves, resembling a slight ground swell, reaching the shore from an otherwise calm sea, there being no wind. The character of the waves was rather peculiar, and I then saw that every now and then, at intervals of about two or three minutes, much larger waves came in, and instead of breaking abruptly, extended quietly up the sandy beach to a greater height than was expected from their apparent elevation. I mentioned the phenomenon on reaching the house, and on the suggestion that the waves were the result of a distant storm, could not see that they might be so accounted for. Between 12 and 1 p.m. I again watched the undulations, and roughly measured the length on the beach by which the larger waves extended further than those of ordinary size. This was about 22 feet. The larger waves were less frequent than in the morning. Later in the afternoon, soon after 3 o'clock, some of my family were caught by the exceptionally large undulations, which rose surprisingly high upon the slightly sloping sand.

I have not heard whether any remarkable disturbance has been recorded by the seismometer, but I see in the *Daily Mail* and *Daily Express* of April 25 and 26 telegraphic reports of earthquakes in Italy, Portugal and Guernsey on April 24.

ROLLO RUSSELL.

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## *RECENT DEVELOPMENTS IN ELECTRIC SIGNALLING.*

IT is thirteen years since Hertz carried out the brilliant series of experiments which, apart from their great theoretical value, had the important effect of laying the foundation of modern systems of wireless telegraphy. Three years later we find the *Electrician* making the suggestion that the discoveries of Hertz might be utilised for signalling to lightships, and five years later still, in 1896, Signor Marconi brought over to England the first practical wireless telegraphic apparatus and awakened public interest by the remarkably successful experiments which he carried out on Salisbury Plain and across the Bristol Channel. For a time the technical and lay Press was full of wireless telegraphy; great prospects were predicted for it; communication with lightships and lighthouses was the least of the feats it would accomplish; telegraphy at sea was to become as common as on land; some even went so far as to say that wires and cables of all sorts for telegraphic purposes were to become a thing of the past. But these revolutionary changes, if they are ever to be made, did not come with the rapidity which many apparently expected. It was soon recognised that we needed to know a great deal more about the subject before Hertz waves were to be even a trustworthy servant to the telegraphist, and even now we can scarcely call wireless telegraphy much more than experiment. But we have now more definite grounds for feeling sure of its ultimate success, and we can predict for it a useful future with much more surety and reason than was done in the first outburst of enthusiasm that followed Mr. Marconi's experiments.

The patient and persevering experimenting of the past five years has led to the gradual surmounting of many of the difficulties which at first beset wireless telegraphy, and Mr. Marconi, Prof. Slaby and the other pioneers who have thrown themselves with vigour into its development have met with a success which, if not complete, is yet very promising. It is not the greatly increased distance over which it has become possible to signal, an increase from a few miles in 1896 to more than 200 in 1901, that marks the most important development that has occurred. The greatest achievement is the successful solution of the problem of tuning. It was early seen that before wireless telegraphy could have at all an extended utility it would be necessary to find some means of confining each message to its correct destination and of preventing each receiving apparatus from responding to Hertz waves sent out from any transmitter in its neighbourhood. It seems that now almost all experimenters have overcome this difficulty, at any rate to a certain extent.

The improvement in distance over which it is possible to signal has been very marked. The empirical law put forward by Mr. Marconi that, other things being equal, the distance over which signalling would be possible was proportional to the product of the heights of the masts at the two ends seems to be fairly well established as a working rule. But the improvements in transmitting and receiving apparatus have been so great that it is now possible to signal over much greater distances with the same heights of masts than was the case in 1898. For example, in 1898 Mr. Marconi was only able to cover 15 miles with vertical wires 120 ft. high, whereas to-day, according to the recent announcement made by Prof. Fleming, a distance of 200 miles from the Lizard to St. Catherine's, Isle of Wight, has been signalled over with masts only 160 ft. high. Mr. Marconi certainly holds the record for long distance work. The example just quoted refers to signalling across sea; across land such great distances have not been attained, but here again we think the credit of having signalled over the greatest distance must be given to Mr. Marconi, who established in 1899 communication between Dovercourt and Chelmsford, a distance of more than 40 miles.

These long distances have been attained by Mr. Marconi partly by the use of a specially constructed transformer in the receiving circuit. Instead of connecting the vertical receiving wire in series with the coherer it is connected in series with the primary of this transformer, the secondary of which is in series with a condenser and the coherer. By this means the voltage of

the received oscillations is increased, and the resistance of the coherer more easily broken down. A somewhat analogous arrangement is used by Prof. Braun, to whose work allusion has already been made in NATURE,[1] in the transmitting circuit, the oscillations in the vertical wire being set up by induction and not by directly including the spark gap between the vertical wire and earth. The results that have been obtained by Prof. Braun are not, however, nearly so good as Mr. Marconi's latest work.

So far as tuning is concerned, Mr. Marconi appears to have successfully got over this difficulty. Prof. Fleming, in the lecture above referred to, stated that the communication between the Lizard and St. Catherine's was multiplex, it being possible to receive two or more messages at once at each place. Mr. Marconi himself, in an interview with an American contemporary, said that with his improved apparatus he could send or receive 2, 10 or 50 messages at the same time, without any interference whatever. Particulars as to the method have not, however, been published as yet, but it is to be hoped that the details of the system will be explained by Mr. Marconi at his forthcoming lecture at the Society of Arts.

In Germany the subject of wireless telegraphy has been tackled principally by Prof. Slaby and Count Arco, who took up the subject in order to find a system for the German Navy, to replace that of Mr. Marconi, the Marconi Company charging, it was said, prices prohibitive to any but the English Navy. Although the results, so far as distance is concerned, which Prof. Slaby has obtained are not very great, the system that he has developed is one of great interest and seems to be founded on sound scientific principles. Prof. Slaby has aimed throughout at getting rid of interference by producing only oscillations of a definite wave-length and tuning the receiver only to respond to these particular waves. In order to produce the oscillations, the transmitting circuit is arranged as shown in Fig. 1. An earthed loop of wire, ACDE, is used, instead of the single insulated vertical wire usually employed, in one arm of the loop there being a spark gap, AB, and a condenser, K. The ends C and D of the vertical wires are joined by a coil of wire as shown. In charging the condenser the whole loop is used, but in discharging it is only the arm ABC which is utilised, the coil of wire CD preventing the oscillations passing into the remainder of the circuit. Upon the length of the wire KC and the capacity of the condenser K the wave-length of the oscillations depends, and from their known values it can be calculated.

Theoretical considerations showed Prof. Slaby that the free ends of both the transmitting and receiving wires, *i.e.* the ends C and E (Fig. 2), are potential loops, and that the earthed ends B and D are potential nodes. If, now, to the receiving wire DE a second wire, DF, equal in length to CD, is connected, there will be a potential loop at F. At E and F, therefore, the potential will vary over a much greater range than at D. If at F a further length of wire, J, is attached, such that its length is half a wave-length, then there will be established between F and the free end, G, of the coil J a difference of phase of 180°. At both points there will be potential loops, but when the potential F has a maximum value in one direction that at G will have a maximum value in the opposite direction, and the potential difference between F and G will be double that between F and earth. By connecting the coherer between F and G it can thus be made to respond to received oscillations much feebler than those which would be required to work it if it were connected, as is usual, between D and earth. As an additional advantage, the earth connection at D can be removed, and the whole receiving apparatus thus rendered earth free.

Experiments have been made from time to time to devise a suitable repeater for use with wireless telegraphy, and the results of some work which has been done by M. Guarini on this subject were recently published in the *Electrician*.[1] M. Guarini established stations at Brussels, Malines and Antwerp; messages were successfully transmitted between Brussels and Malines and also between Malines and Antwerp, and a repeater was then set up at Malines with the object of automatically transmitting the messages received from Antwerp to Brussels. The experiments were not, however, very successful, as the repeater did not always transmit the signals, and it was found, consequently, impossible to send any actual messages. A trustworthy repeater for wireless telegraphy would be very useful, but it is scarcely necessary to point out that it must be absolutely trustworthy, as if a man has to be on the spot to keep it up to its work he may as well be employed in retransmitting the messages.

In the meantime the wire-using telegraphists have been by no means panic stricken by the achievements of their wireless competitors, and some very notable developments have taken place during the past few years. We can only describe here a few of these; those who are more deeply interested in the subject may be referred to Mr. Gavey's paper on telegraphs and telephones at the Paris Exhibition, read recently before the Institution of Electrical Engineers,[2] in which will be

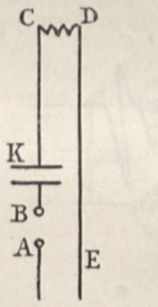


FIG. 1.

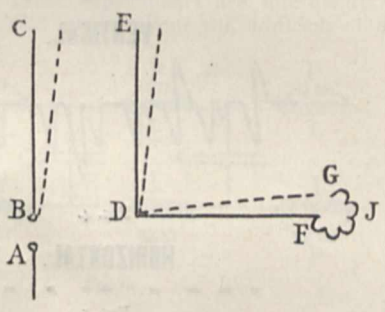


FIG. 2.

found descriptions of all the more important improvements effected in the last few years. One of the most remarkable is the Pollak-Virag high-speed telegraphic system. This system attracted considerable attention both in the technical and lay Press when it was first brought forward, towards the end of 1899, on account of the extremely high speed of signalling which it was said to be possible to attain by its use. It was reported that in trials in America a speed of 60,000 words an hour had been maintained over a line which was over 1000 miles in length, and that a speed as high as 100,000 words an hour had been attained. This is a very great improvement on the 400 or 500 words a minute possible with the Wheatstone automatic or Delaney multiplex systems, which are those commonly in use in this country. These remarkable results had been achieved by the use of a telephone diaphragm as the receiving instrument, the diaphragm being deflected by the currents received through the telegraph line and a deflection in one direction corresponding to a dash and in the opposite direction to a dot. The movements of the diaphragm were recorded photographically, a small mirror being attached to the diaphragm and a ray of light being reflected from this on to a revolving drum covered with a roll of sensitised paper. The record had, of course, to be subsequently developed in the ordinary manner.

Since its first introduction the system has undergone considerable development, a very ingenious modification

[1] NATURE, 1901, vol. lxiii. pp. 403 and 474.

[1] The *Electrician*, March 22, 1901, vol. xlvi. p. 819.

[2] *Journal* of the Institution of Electrical Engineers, 1901, vol. xxx. p. 73.

having been introduced by means of which the recorded message is written in ordinary Latin characters and can consequently be read by any one. In order to do this it is necessary to give the mirror on the receiving instrument a horizontal as well as a vertical motion, and for this purpose two circuits are needed and two telephone diaphragms, one giving the mirror vertical movements and the other horizontal. A single metallic loop is employed, one telephone being put in the loop and the other between the loop and earth. Horizontal movements of the mirror, to right and to left, are produced by currents passing round the loop in one direction or the other respectively, and vertical movements by currents passing from the loop to earth ; in this second case an upward movement is produced by a current in one direction and a downward movement by a current in the opposite direction, and also a downward movement of double the distance by a current at double the normal voltage.

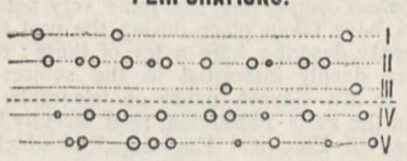


FIG. 3.

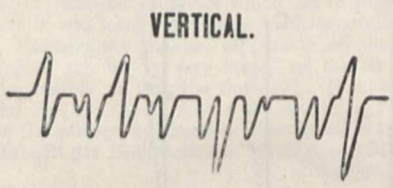


FIG. 4.

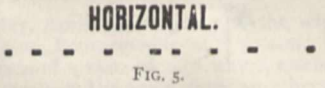


FIG. 5.

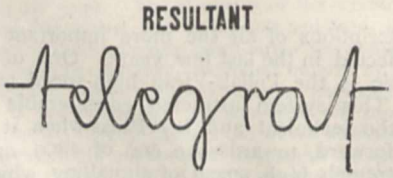


FIG. 6.

The line currents are sent by means of perforated strips of paper much in the same way as in the Wheatstone transmitter, but five strips are used, three to give the vertical components and two for the horizontal. These strips are shown in Fig. 3 ; the rows marked i, ii and iii give the vertical components, the first row giving the tall letters and the third the deflections of double amplitude for the letters with tails ; rows iv and v give the horizontal components. Deflections of a fraction of the normal amplitude are given by contacts lasting a shorter time by means of the small perforations as seen in rows ii, iv and v. The perforations are so arranged that the combination of the vertical and horizontal movements of the mirror (as seen in Figs. 4 and 5 respectively) gives the Latin characters (Fig. 6), and all the perforations for one letter are punched at the same time by means of a special machine of the typewriting kind. To obviate the difficulty of having to use a rapidly moving narrow strip of sensitised paper to receive the photographic record, as in a tape machine, a very neat device is employed. The source of light is the filament of an incandescent lamp, which is surrounded by an opaque cylinder in which a helical slit is cut. This cylinder is revolved, and as it turns the part of the filament acting as a source of light moves from left to right as the slit uncovers in succession the various portions of the filament ; at the same time, the spot of light reflected on to the recording paper, which is a broad band of sensitised paper, will also move from left to right, thus writing a complete line on the paper ; at the end of a complete revolution the spot will return again to the left-hand side of the paper band and will proceed to write a new line, this new line being brought under the other by a movement imparted to the band of paper. The message is thus directly obtained as an ordinary written message in lines one below the other, and the system has thus the great advantage over all Morse methods that the message has not got to be deciphered and transcribed by the receiving telegraphist. With this apparatus it is said that a speed of 1000 words a minute can be obtained.

The Pollak-Virag system, although in its most recent form it gives a record in ordinary handwriting characters, must not be confused with those systems designed to transmit the actual handwriting or drawing of the signaller. Several instruments, under the name telautographs, have from time to time been devised for this purpose, and the late Prof. Elisha Gray was, we believe, engaged on the perfecting of an invention of a telautograph at the time of his death. The attempts at solving the problem, which is, it must be confessed, a very fascinating one even though the very extensive utility of such an instrument may be questioned, have not, so far, proved very successful. Last year, however, there appeared in the technical Press descriptions of a telautograph which is the invention of Mr. Foster Ritchie, and which seems to have got over the difficulties in a very practical manner. In the Ritchie telautograph the message is written with an ordinary pencil ; by means of levers attached to this pencil its movements are made to regulate the currents sent through the transmitting lines, and these currents in their turn regulate the motion of a pen at the receiving end. By an ingenious arrangement the receiving pen only makes marks on the paper when the transmitting pencil is pressed down on the writing table. The receiving pen exactly reproduces the characters written at the transmitting end, which can be written at the ordinary speed of handwriting. We hope on a later occasion to give a more detailed description of the apparatus.

We may finally describe an invention which has aroused considerable interest amongst our American cousins, namely, Dr. Pupin's system of long distance and oceanic telephony. Dr. Pupin has, we understand, disposed of his American patent rights to the American Telephone and Telegraph Company for a very large sum of money, which shows that this company have great confidence in the invention. The difficulty of carrying out successful telephony over a great length of line arises out of the fact that the line possesses both resistance and capacity ; this is especially the case with submarine cables in which the capacity is large. These properties produce both attenuation and distortion of the transmitted signals, the arrival current being both very much weaker and different in character to the current sent into the cable at the transmitting end. The alteration in character is due to the fact that the more rapidly varying currents are more easily attenuated ; if a varying current be sent into the cable by speaking into a telephone at the transmitting end this may be analysed, just as the sound to which it corresponds may be analysed, into a fundamental vibration and a number of higher harmonics ; the higher harmonics will, after travelling along the cable to a certain distance, become so attenuated that they will be incapable of producing any effect on a receiving telephone, so that such an instrument, if placed at this point, will only

be actuated by the fundamental lower harmonics, and the sound it gives out will, in consequence, be different in character from the sound originally made at the transmitting end. The effect will show itself, therefore, in defective articulation, or distortion of the sounds arising out of the distortion of the telephone currents.

It has been shown by Mr. Oliver Heaviside that there are ways in which this distortion may be prevented and a "distortionless circuit" constructed. Without entering too deeply into the subject we may point out briefly the methods by which this may be effected. Since the cable possesses capacity, the first effect of sending current into it is to charge it, and no signal can be received at the far end until the cable is partly charged, and no further signal until the charge has had time to get out. Now if the insulation resistance of the cable be diminished, the charges will more readily leak out and thus it would be possible to expedite signalling ; but at the same time the attenuation is increased, for more of the current will leak out of the cable ; the remedy is, therefore, only a partial one, for though the speed of signalling may be increased, so much current will leak out on the way that the amount arriving at the far end may be too small to work the receiving instruments. Instead of simply diminishing the insulation resistance or of distributing artificial non-inductive leaks along the cable, inductive leaks may be placed at definite points along the cable ; this method was proposed by Prof. S. P. Thompson in a paper read at the International Congress at Chicago in 1893.[1] A diagram of the cable construction suggested by Prof. Thompson is shown in Fig. 7 ; the capacity is represented as though it were not evenly distributed but

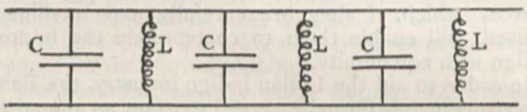


FIG. 7.

consisted of a number of condensers, C,C, connected as shunts to the cable ; the inductive leaks are represented by the coils L,L. The capacity and self-induction are therefore combined in parallel, and it is well known that they can be combined in this way so as to behave, for a definite frequency, exactly as an ohmic resistance. The capacity of a submarine cable may be partially neutralised in this way, but the remedy is only a partial one for three reasons. Firstly, the inductive leaks, to correctly neutralise the capacity, should, like the capacity itself, be evenly distributed along the cable and not distributed in jerks ; secondly, the correction will only be exact for a particular frequency ; lastly, the leakage is increased and the same defect consequently occurs as in the case considered above in which the distortion was corrected by diminishing the insulation resistance. Theoretically, therefore, the system proposed by Prof. Thompson does not offer a perfect solution or give a truly distortionless circuit ; but it would greatly diminish the distortion, though at the same time increasing the attenuation, and might therefore give a practical means of increasing the speed of signalling or even obtaining telephonic communication over the cable.

As Mr. Heaviside has shown, the only true way of obtaining a distortionless circuit—of obtaining *the* distortionless circuit, as he calls it—is to balance the effect of capacity by self-induction *distributed along* the cable in series with it and not as a leak to it. The four quantities which control the propagation of disturbances or signals along the line are its resistance, R, its external conductance, or conductivity of the insulation, K, its self-induction, L, and its capacity or "permittance," S, and the signals will be propagated without distortion if

[1] See the *Electrician*, August 1893, p. 439.

L/R=S/K. The equality of these two ratios may be obtained by altering any of the four variables, but practically we may consider R and S as fixed. In ordinary cables the value of the ratio L/R is very small, and that of S/K comparatively large. In order to make the two equal we may increase K, that is to say diminish the insulation resistance, but this, as we have seen, leads to excessive leakage and is not, therefore, desirable. The method suggested by Prof. Thompson amounts practically to converting the capacity, S, partly or wholly into insulation conductivity, K, and thus diminishing S/K until it is as small as L/R. The self-induction coils added in this system must not be confounded with the self-induction of the cable L, for they are added as shunts to the cable. The ratio L/R may also be made equal to S/K by adding self-induction coils in series with the cable, thus increasing the value of L ; this is the solution adopted by Dr. Pupin. Here again the ideal solution is only obtained when the self-induction is evenly distributed, but a practical solution can be obtained by placing coils at intervals along the cable.

Dr. Pupin, besides repeating a good deal of Mr. Heaviside's theoretical investigations, worked out the necessary values of the self-induction of the coils and the maximum distance apart at which they can be placed in order to imitate sufficiently well an evenly distributed self-induction. He then proceeded to build some coils and to experiment with them on an artificial cable. The results of some of these experiments are interesting, as they point to the great improvement the addition of the

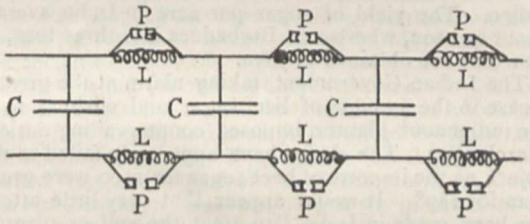


FIG. 8.

inductance produced. An artificial cable was built up with condensers in the usual way in 250 sections, each section representing a mile of cable ; between each section were placed induction coils which could be short-circuited by plugs. A diagram of this cable is given in Fig. 8 ; as before, the capacity is represented as if it consisted of condensers, C,C ; the induction coils are shown at L,L ; these coils are short-circuited by inserting the plugs at the contacts P,P. When all the coils were in circuit telephonic communication could be carried on with perfect ease over the whole length, 250 miles, of the cable ; when, however, the coils were short-circuited conversation was good up to 50 miles only, fair up to 75, impracticable at 100 and impossible beyond 112. It must be remembered in considering these results that the cable was an artificial one and that possibilities of error are consequently great, so that the results must not be transferred with too much confidence to the case of an actual cable.

Apart from this, however, the results are extremely good, and Dr. Pupin is to be congratulated on having obtained experimentally a practically distortionless circuit. It is perfectly true, no doubt, that Mr. Heaviside had obtained the solution already theoretically ; but the engineers generally require to have their attention attracted by actual experiment and are not too prone to make changes on a theoretical basis only, however sound. Whether a cable can be commercially constructed on the lines of Dr. Pupin's artificial cable is a question for the practicians ; we have no doubt that, now its advantages have been demonstrated, they will be able to find a way. The enormous advantage of Transatlantic telephony can never

for a moment be questioned ; it means much more than that we shall be able to telephone to America ; it means that we shall be able to telegraph at the speed of the automatic transmitter. The present speed of Trans-atlantic telegraphy is something like 20 words a minute, and there are 12 duplexed cables having, therefore, a carrying capacity of about 500 words a minute. A single distortionless cable, built on Dr. Pupin's plan and working with an automatic transmitter, would have, therefore, a carrying capacity equal to that of all the existing cables.

## *INDIGO AND SUGAR.*

THE Behar Sugar Commission, which was appointed in October of last year to see whether improvements might not be made in the cultivation and manufacture of cane sugar, has completed its task. The report has been issued with commendable promptitude—scarcely five months having elapsed from the appointment of the Commission to the presentation of its report. The Commission was primarily appointed because of the perilous position of the indigo industry, to see whether it might not be possible to grow the sugar cane and indigo crops in rotation.

The *Times* of April 15 contains an article upon this report. One thing the Commission seems to have made clear is that the methods employed in the sugar industry have been on the same happy-go-lucky slip-shod fashion as those until lately used in the manufacture of natural indigo. The yield of sugar per acre in India averages about one ton, whereas in Barbadoes it is three tons, and four tons are obtained in Java.

The Indian Government, taking alarm at the great increase in the imports of beet sugar and wishing to aid the indigenous planter, imposed countervailing duties in March 1899. The duties have apparently failed in their object, as the imports of beet sugar for 1900 were greater than for 1898. It would appear that very little attempt has been made in India "to treat the soil or plant the canes on scientific principles," and that the methods of refining the sugar are rough, crude and wasteful, so that under such conditions the yield of the finished article is not what it should be, and the quality is poor ; Indian sugar is, therefore, unable to compete with sugar refined by modern scientific methods and appliances.

It is further stated that there is an increasing tendency in India to prefer sugar which has been refined to unrefined sugar. The Commission recommend the employment of modern and up-to-date apparatus. We are glad to note that they do not recommend indiscriminate help to the individual planter or refiner, but suggest that such assistance as is desirable should be given in helping systematic experiments at a central station.

Turning now to the indigo industry, which was the primary cause of the appointment of the Commission, we find that the indigo planter, now thoroughly alive to the danger which threatens him, is exerting himself to improve the yield of indigo. In the first place, by the employment of artificial manures, principally superphosphates, an increased plant production of from 50 to 100 per cent. has been obtained. In manufacturing indigo, it will be remembered (NATURE, November 1) that it is usual, when the plant has reached maturity, to cut it near to the ground and to steep the whole plant. After a few months the fresh shoots which have sprung up are again cut, but the yield of indigo from this second crop is inferior to that obtained from the first. It has been suggested, seeing that almost the whole of the colouring matter is contained in the leaves, that the plant should not be cut down, but that the leaves only should be stripped off and steeped. It is calculated that four or five strippings could be obtained during the manufacturing season, and thus a very much larger quantity of indigo would be produced than by the methods at present in vogue.

The old beating process for oxidising the liquors obtained after the plant has been steeped is gradually being replaced by the use of the "blower." In this method air is blown through a number of perforated pipes which are placed at the bottom of the vats, with the result that oxidation is more rapid and complete, and about 25 to 30 per cent. more colouring matter is produced than by the old process. Mr. Rawson, in addressing a meeting of those interested in the indigo industry at Calcutta on February 20, said that the output of indigo in North Behar last year amounted to about 60,000 maunds,[1] and that at least 12,000 maunds more would have been produced had the new "blowing" process been employed.

A manufacturing industry, such as that of indigo, which is to a large extent dependent upon atmospheric conditions, has naturally seen many dark days. But when the supply has been short there has generally been an enhancement in prices. The Commission is of opinion that a rise of price owing to bad seasons or short supplies can no longer be looked for, and say in their report : "It is reasonable to anticipate that the competition of synthetic indigo will prevent any future increase in the price of vegetable indigo, that it will soonest and most injuriously affect the finest and most expensive indigo, which is that of Behar, and cause a further reduction in price, which would hardly clear the planter in a good season, while a bad season would be ruinous to him." They go on to say, "it is obviously expedient that indigo planters should possess in sugar and other products resources which, if they are carefully and intelligently utilised, will enable them to contemplate the future of indigo with equanimity."

In order to aid the Indian indigo industry, the Bengal Government has formally agreed to grant an annual subsidy of 50,000 rupees for three years for further chemical and scientific researches with regard to indigo cultivation.

Indigo planters claim that at present the natural dye can be placed on the market at prices which can undersell the synthetic product. This is good news, but it is difficult to see how it is in the long run to hold its own against the artificial product, which is of uniform quality, requires no grinding, and is unaffected by vicissitudes of weather.

Prof. Armstrong, in a long letter to the *Times*, says that "The truly serious side of the matter, however, is not the prospective loss of the entire indigo industry so much as the fact that an achievement such as that of the Badische Company seems to be past praying for here."

Whether or not the natural indigo industry is to become a thing of the past remains to be seen, but if the replacement of natural indigo by a synthetic article produced in Germany leads British manufacturers to realise more fully the importance of trained scientific assistance, the decline, although in itself a great calamity, might not be entirely without its compensations.

Since writing the above, I have received a copy of an address upon "The Synthesis of Indigo," delivered by Prof. Meldola before the Society of Arts on April 17. In introducing the subject Prof. Meldola says that it is now often considered unpatriotic to "call public attention to any branch of industry in which we are being beaten by foreign competitors." He, however, considers that "The real enemies of British industry are those who, by virtue of their positions as politicians, economists, or as men of science, try to blind the public and to allure the manufacturer and merchant into a fool's paradise of false security."

[1] The Bengal factory maund is 74·66 lbs.

Then follows a very lucid and interesting historical survey of the chemistry of synthetic indigo. Attention is called to the fact that the first patent bears the date of March 19, 1880, and that although we knew that artificial indigo prepared by this, the cinnamic acid synthesis, could not compete with the natural product, yet its appearance caused much consternation among indigo planters. But because the threatened storm did not break, the planters evidently quickly forgot their fright and returned complacently to their old rule-of-thumb methods. Not so the chemists; they steadily and perseveringly plodded on, and in 1882 von Baeyer and Drewson brought out another synthesis, viz. the condensation of acetone and orthonitrobenzaldehyde in presence of caustic alkali. This process, or a modification of it, is employed at the present by the firm of Messrs. Meister, Lucius and Brunning; but as the supply of the raw material—toluene—is limited, Prof. Meldola, speaking as an individual, says: "Were I a planter, I should have no anxiety whatever with respect to a competing product which starts from toluene." Every 1000 gallons of coal tar yields about 6¾ gallons of benzene and 3¼ gallons of toluene, therefore any process which started with benzene as the out-going product should be better able to compete than one in which toluene is the starting material. However, although there are several syntheses which start from aniline (produced from benzene), the methods employed are so costly that at present the planter has very little to fear in this direction.

Naturally the chief portion of the paper is devoted to Heumann's synthesis, as at present worked by the Badische Company. This process, which starts from naphthalene, the supplies of which are practically unlimited, was described in NATURE, November 29.

In his references to the Badische Company Prof. Meldola quoted the following facts from the official report prepared for the Paris Exhibition:—

"The factory at Ludwigshafen employs 148 *scientific* chemists, 75 engineers and technical experts, and 305 members of the mercantile staff. In 1865 they commenced with 30 workmen, and they now employ over 6000. The consumption of coal is about 243,000 tons per annum; water is supplied to the factory to the extent of some 20,000,000 cubic metres annually; they make 12,000,000 kilogrammes of ice, and over 12,000,000 cubic metres of coal gas in the course of the year. The electric installation consists of eight dynamos, the currents from which serve for illumination, motive power and electrolytic processes. Steam is supplied from 102 boilers, which serves for heating purposes and for driving 253 steam engines."

Let the British manufacturer and the Indian indigo planter try to digest these hard facts and figures. I wonder whether there are 148 *scientific* chemists employed by manufacturers in the whole of the United Kingdom. Let them also remember that these figures only refer to *one* firm.

Finally, Prof. Meldola refers to the natural product *versus* synthetical indigo. He is unable to hold out the hope that the natural article will in the long run be able to compete with the product of the German factory. "The planters have allowed twenty years of activity on the part of the chemists to pass by with apathy and indifference, and at the last moment only have they called in expert assistance."

It is truly marvellous that only the British planter should have been so lethargic. In Java the Dutch planters "have had the wisdom to avail themselves of the resources of the botanical gardens for experimental purposes, and their chemists and bacteriologists working in Holland in co-operation with the planters have, as is well known, for many years past been contributing to chemical literature the results of their investigations."

Reference is made to the contradictory opinions as to what goes on in the steeping vats, as to whether the resolution of the glucoside indican into indigotin is due to bacterial fermentation, or whether it is one of ordinary zymolysis. Attention is also directed to the drying process, which often extends over several weeks, and during which time it is stated that a fungus grows on the cakes and ammonia is evolved. Prof. Meldola asks whether this may not be due to the destruction of indigo by a micro-organism. I have myself often wondered that in all the suggestions for improving the yield and quality of indigo no one appears to have drawn attention to this apparent decomposition. It seems possible that more thorough washing and rapid drying in a current of hot air would perhaps prevent this. In his closing remarks Prof. Meldola refers to the antiquity of the industry, and questions whether the methods at present employed in India are very different to those used in the time of the Pharaohs.

F. MOLLWO PERKIN.

## *THE OLDER CIVILISATION OF GREECE.*[1]

THE sixth volume of the *Annual of the British School at Athens* contains matter of extraordinary interest to students of the history, not only of Greece, of Egypt and Western Asia, but also of mankind in general. The culture which now dominates the world is the child of the civilisation of Ancient Greece, and any archæological discovery which tends to increase our knowledge of the beginnings of Greek civilisation possesses an importance and an interest far greater than that of any other possible discovery whatever in the archæological field.

For the last twenty years, since Schliemann first unveiled the treasures of the citadel of Mycenæ, it has been recognised that the culture of classical Greece as we know it is but the second epoch of Greek civilisation. Classical Greece had a past the true history of which had been half forgotten, had been preserved in confused and contradictory legends. The culture of the past had bloomed from end to end of the Greek world, in cities, some like Athens or Knôssos, of renown in classical as well as præ-classical days, others like Mycenæ and Tiryns, cities whose fame ceased to be when the Dorians entered Greece. This culture was bronze-using, and was, in fact, the Greek phase of the European culture of the Bronze Age, a phase earlier in date than the phases of Central and Northern Europe, and in all probability not only their forerunner, but to a great extent their forbear. This culture itself developed out of a stage of transition from Neolithic barbarism, which we call "præ-Mycenæan," during which stone, copper, and occasionally bronze, were used side by side, pottery was rude and unpainted, and the dead were buried in *cist-graves*. This stage shades off on the one side (as in the first city of Troy) into the Neolithic culture, on the other (as in Cyprus) into Mycenæan civilisation, which marks the first stage of real "civilisation," properly so-called, in Europe. The earliest stages of the Mycenæan culture are known to us from discoveries of settlements with pottery, &c., in Thêra, at Phylákopê in Melos, at Kamárais in Crete, and other isolated spots, chiefly in the Southern Ægean islands. The civilisation which we find at Mycenæ, at Vaphio, at Ialysos and elsewhere, is the same as that of Phylákopê and Kamárais, but is more highly developed in many ways. This can only be the culture of the heroic Achaians, which was overthrown by the Dorians; its date must, then, be placed certainly before 900 B.C., even if, as is very possible, it continued to exist in Western Asia Minor and Cyprus till the eighth century. We can be more certain about its date than this; Mycenæan culture was by no means confined to

[1] *The Annual of the British School at Athens*; No. VI. Session 1899-1900. Pp. viii + 156. With illustrations and two maps. Printed for the subscribers and sold on their behalf by Macmillan and Co., Ltd. Price 10*s*. 6*d*.

Greece, and there were ships and sailors in those days as bold and venturesome as any of the time of Elizabeth. We know from the Egyptian State archives of the reign of King Akhunâten (B.C. 1430 : date determined by synchronism with Burraburiyash of Babylonia, B.C. 1430) that in the XVth century B.C. the Phœnician cities already traded with many lands across the seas, with Egyptian Thebes, with Alashiya or Cyprus (?), and with *Keftiu*. The people of *Keftiu* came to the court of King Thothmes III. of Egypt (B.C. 1550) with gifts.

Where was *Keftiu*? Mr. A. J. Evans tells us this in this sixth volume of the *Annual of the British School at Athens*.

Mr. Evans's excavations at Kephala, the site of Knôssos, in Crete, are the culmination of many attempts, pursued during several years past under difficulties of all kinds, to elucidate the early history of Greek civilisation in Crete. The traditions of the island point to its having occupied a position of especial prominence in the Mycenæan world, and Mr. Evans's hopes of great results from Cretan exploration have not been disappointed. He has not only discovered at Knôssos a Mycenæan palace of the first "Kamárais-period," continued to be occupied down to the period of its sudden sack and destruction by fire towards the end of the Mycenæan age, at which time only vessels of the later type were in use, while in the town we have two strata of settlement, the one containing the vases of the earlier period, the other those of the later generations of inhabitants. There need be no question of a change of race here, though Mr. Hogarth seems to suggest it. Alteration of style in art is no proof of racial change. Such changes are simply due to an alteration of fashion, suddenly started by some artist. We have an example of a sudden alteration of the kind in Egypt in the early years of the XVIIIth Dynasty. But we do not therefore in this case assume the violent substitution of one race of inhabitants by another. Even alteration of burial customs is no clear proof of change of race.

Important as the relics of the "Kamárais-period" from the Knôssian town are, however, they pale before the importance of the discoveries made in the palace itself. The excavation of this, probably the most important Mycenæan building yet discovered, is only begun, and we know not how Mr. Evans may increase our knowledge

FIG. 1.—Protomycenæan Vases from Knôssos: probable date before 1600 B.C.

rank, which is very probably identical with the legendary "Labyrinth" of Minôs, but has also discovered that the Mycenæans of Crete were in all probability the same people as the "Men of *Keftiu* and of the Isles in the midst of the Very Green" (*i.e.* the Mediterranean), who make their appearance in Egyptian history *c.* 1550 B.C., thus giving the earliest trustworthy date for the Mycenæan civilisation.

Not only the palace, but also the Mycenæan town of Knôssos was discovered in the course of these excavations. The exploration of the town ruins was carried on by Mr. D. G. Hogarth, late Director of the British School at Athens, Mr. Evans busying himself more especially with the exploration of the palace. It is noteworthy that vases and fragments of vases found in the town ruins were of the early Mycenæan or "Kamárais" type, while those found in the palace mostly belonged to the fully-developed Mycenæan types so well known to students of early Greek art from the great work of Messrs. Furtwängler and Löschcke. This does not necessarily mean that the town-ruins are all older than the palace; all that is implied is that the palace, which from various indications was evidently already in existence in the of the older civilisation of Greece in the course of his diggings this year. What he found last year, however, gives us material enough to think about! The plan of the palace shows a vast labyrinth of chambers, halls, corridors and passages; a true labyrinth indeed, for it is the only genuine and original Labyrinth itself, as the constantly-recurring symbol of the double-axe, the emblem of the later Zeus of Λαβραυ-νδα, which is etymologically the same word as Λαβύρι-νθος, "The Place of the Λάβρυς or Double-Axe" (for the earliest Mycenæans of Knôssos and elsewhere were not Aryan Hellenes, but "Pelasgians" allied to the non-Aryan peoples of Asia Minor), the emblem of the Knôssian Zeus, Ζεὺς ἄναξ, Πελασγικὸς, shows. This is the labyrinth of Minôs: is the bull-headed Minotaur, child of Zeus, of whom legends passed to the succeeding Hellenic inhabitants of the land, the recollection of some Mycenæan deity to whom human sacrifice was offered at Knôssos? We know the love of the Mycenæans for bulls, we see the *protomae* of bulls at Mycenæ and among the gifts of the *Keftiu*, we find pictures of ταυροκαθάψια, bull-catching, at Tiryns and elsewhere, we have the splendid life-sized relief of a bull's head in painted *gesso duro* from Knôssos itself (Fig. 10

of the work under review); there are hundreds of other instances. The bull was the beast of Zeus: the idea of a Phœnician origin of the Minotaur is just so much rubbish; he is a purely Mycenæan conception. And his master, Minôs? What would Mr. Grote have said had he been told that in 1901 the name of Minôs would pass

FIG. 2.—The Fifth Magazine, showing Great *Pithoi* and Receptacles in the Floor.

from the realms of pure myth into those of historical probability? Yet we have what look very much like the remains of a great Cretan power dating long before the Return of the Herakleids, in fact the power and kingdom of Minôs. The evidence of Greek legend can no longer be scoffed at, and the tradition of the Minoan thalassocracy may yet be shown to contain a substratum of historical fact. Those *Keftiu* went far afield: they reached Egypt. Sicily and Kamikos are no farther.

The records of Knôssos have much to tell us, but as yet they are dumb. There they lie before us, those queer characters incised on tablets of sun-baked clay, but we cannot read them yet. How long we shall continue in this state of tantalising ignorance it is impossible to tell. The lamentable failure to read the so-called "Hittite" script of Eastern Asia Minor is no good augury. This discovery of inscribed tablets is the most important in the field of early Greek antiquities since the excavation of the graves at Mycenæ. The tablets, good illustrations of which are given by Mr. Evans, were found in a number of deposits or "hoards" in the palace, mostly packed away in sealed boxes placed in large πίθοι or handleless vases (a specimen of the kind, brought from Rhodes, is in the First Vase Room of the British Museum), which were stored in special chambers. The writing is of two kinds, hieroglyphic ("pictographic") and linear: in both remarkable resemblances to Egyptian characters are noticeable, and give further proof of the idea, now fast gaining ground, that Egypt exercised no little influence upon the development of Mycenæan culture. On the other hand, the use of clay for the tablets is a sure sign of the influence of the rival civilisation of Babylonia. Many of the tablets evidently contain simply lists of ships, chariots, horses, swine, &c.; so much we can guess from the pictures. The numerical system is evident; further than this we cannot go. It had long seemed curious that the highly-developed civilisation of Mycenæan days should have been ignorant of the art of writing; but we had no conclusive proof of Mycenæan writing before Mr. Evans's epoch-making discovery. Now here are the records of the Mycenæans before our eyes; σήματα λυγρὰ, indeed! They will not want for energetic "Bearbeitung," and the Clarendon Press is already preparing a fount of Mycenæan type! But the omens are bad.

We have remarked that Mr. Evans has shown that the *Keftiu* who brought gifts to the court of Thothmes III. of Egypt, *c.* 1550 B.C., were Mycenæan Cretans. This conclusion is a legitimate one. Some of the finest known examples of Mycenæan fresco-painting have been found in the Knôssian palace, and among them are representations of processions of men bearing vases, &c., who in dress are absolutely identical, on the one hand, with the bull-catchers of the Vaphio cups, on the other with the *Keftiu* who are depicted on the walls of Rekhmarā's tomb at Thebes, in Egypt. No doubt of the identity is possible; the further presumption that the pictures of Rekhmarā's tomb are roughly contemporaneous with the frescoes of Knôssos is backed up by the cumulative force of all the rest of the chronological evidence, besides being inherently probable from the almost exact similarity of costume, &c. The date of *c.* 1550 B.C. for the *later* portions of the Mycenæan palace at Knôssos is thus clearly indicated.

These frescoes give us an inkling of the racial type of the Mycenæans. They are not fair-haired Aryans at all. They are brunett, black-haired, un-Aryan people like the modern Italians, Greeks and Anatolians; they belong, in effect, to the "Stirpe Mediterranea" of Sergi, the race which we may, if we like, call Pelasgian, which preceded the Aryans in Greece as well as in Asia Minor, and of whose peculiar language-type Karian and Lycian give us a good idea. The Aryan

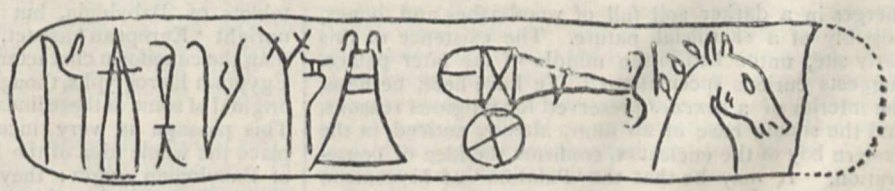

FIG. 3.—Linear Tablet referring to Chariot and Horses and, perhaps, Cuirass. (Size of original.)

conquerors gave Aryan languages to Italy, Greece and Phrygia, but the modern speakers of Italian, of Greek, and of Armenian much more closely resemble their non-Aryan ancestors than their Aryan conquerors.

The palace of Knôssos was built of great gypsum and limestone blocks, and when complete must have been a most imposing building. One of the most curious facts with regard to it is that it is really built round a small open space, which Mr. Evans speaks of as "The Central Clay Area." "This enclosure," says Mr. Evans (p. 17) "turned out to be entirely devoid of foundations, and its floor was composed of the pale clay already noticed as being of artificial accumulation and as probably due to the disintegration of the clay platforms and wattle-and-daub huts of a very primitive settlement. It was found to be full of Neolithic relics, and a shaft sunk near the N.W. corner showed that the deposit was at this point 7·50 m. in thickness. On the south side this clay deposit merges in a darker soil full of wood-ashes and bones, possibly of a sacrificial nature. The existence of this early site, untouched in the middle of the later palace, suggests curious speculations. We have here, perhaps, the interior of a *temenos* preserved for religious reasons, and the square base of an altar, already noticed, in the eastern bay of the enclosure, confirms the idea of consecration. It may be that the 'Palatine' of Mycenæan Knôssos also had its 'Casa Romuli'—a sacral survival of a prehistoric dwelling."


FIG. 4.—Throne-Room as seen from Antechamber.

A chamber of great importance in the palace was the Throne-room, of which Mr. Evans gives a description (p. 35 ff.): "The chamber . . . was in many ways as perfect as the room of a Pompeian house, though some fourteen centuries earlier in date. On the south side opened an impluvium and steps leading down to a fine stone tank. . . . . Breasting this, and along two other sides of the room, ran gypsum benches with pilasters. . . . At the middle of the north wall was an interval between two of these stone benches, the central post of which was occupied by a gypsum throne. The throne rested on a square base and displayed a high back of undulating leaf-shaped outline. . . . Its total height is 1·06 m., and the level of the seat 0·56, or 21 cm. above that of the stone benches. . . . The lower face of the throne presented a curious architectural relief, consisting of a double moulded arch springing from flat, fluted pilasters, expanding upwards in the Mycenæan fashion. The upper part of this arch was traversed by a moulded band forming a counter-curve. But the most interesting feature remains to be described. The lower part of the mouldings of the arch on either side were, by a strange anticipation of later Gothic, adorned with bud-like crockets. The architectural features, indeed, revealed by these reliefs are in almost every respect unique in ancient art."

A splendid idea of this room and of the now famous "Throne of Minôs," can be obtained from the photographs published in the *Annual*, one of which is shown in Fig. 4. In general it may be said that the illustrations are extremely good—the plans also. But for finality in these latter we must wait till Messrs. Evans and Hogarth have brought their excavations to an end. Enough has now been said to give the reader an idea of the immense importance of the discoveries at Knôssos, and it is a matter of congratulation that their discovery has fallen to the lot of an Englishman. Our knowledge of early Greek civilisation in Crete now rests on a much surer foundation than it did when Mr. Evans strove to draw a connected story from the evidence of the "Seal-stones" alone.

To one small point only in Mr. Evans's discussion of his discoveries must we take exception. When speaking of the inscribed tablets he says (p. 57): "Some distant analogy may be recognised with the tablets of Babylonia, but the letters here are of free upright 'European' aspect, far more advanced in type than the cuneiform characters. They are equally ahead of Egyptian hieroglyphs, though here and there the pictorial original of some of these linear forms can still be detected." This passage is very incomprehensible. In the first place the whole idea of the Knôssian tablets is obviously of Babylonian origin: they are not merely "distantly analogous" with the tablets of Babylonia. In the second place, what does Mr. Evans mean by the Mycenæan letters being "of free upright 'European' aspect"? What characters can be called free or unfree? Why is the erect position specially "free" or "European"? The Egyptian hieroglyphs and their hieratic developments stood bolt upright unless a crocodile or a snake were pictured; cuneiform was upright and spiky enough, in all conscience. They are not European. With what European script is he comparing the Mycenæan writing? Surely

not with the Greek alphabet, which was of Phœnician, and ultimately of Egyptian, origin. And how are the Knôssian characters more advanced in type than the cuneiform characters? Obviously they are nothing of the kind; they are in the same stage of development as the Egyptian hieratic writing, to which they bear a strong resemblance; so far, then, it may be said that they are "ahead" of the Egyptian hieroglyphs; but cuneiform was far more conventionalised, far "ahead" of either Egyptian hieroglyphic and hieratic or Mycenæan linear. The people who used the Knôssian script may turn out to have had not one drop of Aryan "European" blood in them, and European-Greek culture may be as thoroughly of non-Aryan (and equally non-Semitic) origin as Semitic culture was in its origin absolutely non-Semitic.

The work of Messrs. Evans and Hogarth at Knôssos has been supplemented by the latter with the very interesting results of his excavation of the famous cave of Zeus on Mount Diktê, an account of which appears on p. 94, ff. Mr. Hogarth's story of his operations, of the blasting of the rocks, the unveiling of the most ancient sanctuary of Zeus, the recovery of small bronze double-axes and other votive objects, belonging to the same period as the Knôssian palace, from the crevices of the stalagmitic deposit in which they had remained undisturbed for nearly four thousand years, the finding of a little Egyptian bronze statuette of Amen-Rā, which shows that somewhere about 1000 B.C. King Zeus was already identified with Amonrasuntiru, Amen-Rā, king of the gods—all this is of the highest archæological interest, and may be recommended to the notice of students of Greek religion.

It remains to speak of the articles of less importance which also find a place in this number of the *Annual*. That by Mr. F. B. Welch on "The Influence of the Ægean Civilisation on South Palestine" is important as chronicling the occurrence of Mycenæan pottery at a Palestinian site, Tell es-Safi. "This," says Mr. Welch, "was certainly a Philistine stronghold, a fact which is suggestive in view of the probable north-western origin of the Philistines" (p. 119). This is quite true, and it may be remarked that the old tradition of the Cretan origin of the Philistines has lately, in view of the Egyptian records of attacks by the Peoples of the Sea, among whom figure the *Pulesatha* or Philistines, and a great deal of other evidence, both archæological and legendary, come once more to the front, and probably represents a historical fact. But Mr. Welch should note that Semitic authorities such as Delitzsch, Jensen, Mayer and Tiele uncompromisingly claim the Philistines as Semites, and specifically Aramæans. The Egyptian evidence, however, as Mr. Welch rightly implies, goes absolutely against the Semitic claim, which will probably have to be given up. Still, the Greek archæologists have no right to ignore the opinion of the Semitists on such a question as this. Mr. Welch seems, by the way, to attach rather too much importance to purely "typological" arguments derived solely from the study of pottery, which can never be an absolutely infallible guide.

Mr. J. C. Lawson's note on "A Beast-Dance in Scyros" (p. 125) will be of great interest to anthropologists. In carnival time the young men of Scyros array themselves in goat-skin capes—"each does his best according to his lights and his means to look like a goat"—hang goat-bells round their persons and solemnly dance through the town, often stopping "at some friendly door to imbibe spirituous encouragement to further efforts." This is undoubtedly a very ancient survival, and possibly goes back to Mycenæan times, a surmise with which anybody who knows what a great part goat-headed and other theriomorphic figures play in Mycenæan art will probably agree. But alas, "thanks to the steadily increasing influx of Western culture during the last few years," the goat-mask is often replaced nowadays by "an Ally Sloper mask"! The modern Japanese wears a billycock or a deerstalker on the top of his national historical costume. So the free and upright civilisation of modern Europe dominates the world!

It may be finally noted that the knowledge which the contributors to this number of the *Annual* possess of the German language appears to be defective. If German terms are used at all, their proper plural forms should be given to them. "Bügelkannes" may be Dutch, but is neither German nor English; Mr. Welch gets over the difficulty, which might have been solved by reference to a German grammar, by giving his German words no plural form at all. He speaks of "Bügelkanne" and "Schnabelkanne" when he means *Bügelkannen* and *Schnabelkannen*.

Despite these little imperfections, the sixth number of the *Annual of the British School at Athens* is undoubtedly the most important contribution to our knowledge of the early history of mankind that has appeared for many years.

## *MAGNETIC OBSERVATIONS DURING TOTAL SOLAR ECLIPSE.*

THE effect produced by a solar eclipse on the meteorological conditions of the atmosphere has on many occasions in the past been the subject of observation, but in the number of *Terrestrial Magnetism* just received we find an account[1] of a systematic examination of the influence of such an eclipse on magnetic conditions also. It had appeared to Dr. Bauer, chief of the U.S. Magnetic Survey, that magnetic observations might on such an occasion be usefully undertaken; and the occurrence of the solar eclipse of May 28 of last year, the total phase of which was visible in the United States, afforded an excellent opportunity of carrying such design into execution. For the needs of the magnetic survey simultaneous magnetic observations are made on certain days throughout the year at the different magnetic stations, and it was arranged that such observations should be made, on the day of eclipse, at stations as near as possible to the path of totality. Six stations were selected; three of them—Union Springs, Rocky Mount and Cape Charles—were situated within the path of totality, the remaining three—Salem, Bayard and Gaithersburg—being outside. The observers received instructions to occupy such stations as their special work permitted for the due accomplishment of the object in view, accompanied by a detailed scheme of the observations to be made. The prescribed course was carried out by all the observers excepting the one at Gaithersburg, who for some reason failed to receive his instructions in time; but he made observations according to directions sent him previously, relating to other work. The detailed scheme of observations is given with the view of aiding observers making preparations for similar work on future occasions. The observations made are discussed at considerable length, being accompanied by numerous graphical illustrations, and it is stated that there can be no question that some kind of magnetic disturbance made itself felt on May 28 at every one of the stations.

Finally, the conclusions arrived at are given under eleven separate heads, the principal points of which are contained in the following summary:—A small magnetic oscillation made itself felt at various stations situated in the eastern part of the United States during the time of the eclipse. It was detected by various persons, at various stations, with different instruments, under different conditions, and was also automatically recorded.

[1] *Résumé* of magnetic observations made chiefly by the United States Coast and Geodetic Survey on the day of the total solar eclipse May 28, 1900.

The various phases of the oscillation did not take place at the different stations at the same absolute time, or local time, but in every instance were associated with the time of maximum obscuration of the sun. The duration of the oscillation was apparently about the same as that of the eclipse, about two and a half hours. The range of the oscillation was about one minute in arc for declination, and about eight units in the fifth decimal C.G.S. for horizontal intensity, that is, to about 1/2800th part of the absolute horizontal intensity. The general effect was to deflect the declination needle to the west, and decrease the horizontal intensity, before the time of maximum obscuration, the movement afterwards being in both cases in the opposite direction. The analysis indicates that the cause producing the magnetic oscillation was situated outside of the earth's crust, the presumption being very strong that the oscillation is to be referred to some change produced in the upper atmospheric regions by the abstraction of the sun's rays, due to interposition of the moon.

Dr. Bauer expresses himself as having been in doubt before making the observations as to whether any magnetic effect referable to the eclipse would reveal itself, and adds that he was afterwards slow to conclude that the magnetic oscillation observed was not accidentally connected with the eclipse, until he had made such exhaustive examination of every point involved as justified him in formulating a definite conclusion. The result is interesting, and makes it desirable, as he says, that every opportunity should in future be taken to obtain, during eclipses, simultaneous magnetic, atmospheric-electric and meteorological observations at as many stations as possible.

It is to be remarked that, although Dr. Bauer eventually speaks with some confidence as to the magnetic movement observed having relation with the eclipse, the movement in question was small, and, abstractedly speaking, much too small on which to found any certain conclusion, considering the abundance of magnetic movements of similar and even greater magnitude. The circumstance that seems really to give weight to the conclusion drawn is the statement that the various phases of the magnetic oscillation were associated with the time of maximum obscuration of the sun. Confirmation of this circumstance is therefore what is now to be desired.

Following the paper there is printed an appeal for international co-operation in magnetic and allied observations during the total solar eclipse of May 17 next.

WILLIAM ELLIS.

## *PROF. H. A. ROWLAND.*

HENRY AUGUSTUS ROWLAND was born in 1848. He was educated as an engineer, and graduated at the Rensselaer Polytechnic at Troy, New York, in 1870. After one year's experience as a railway engineer on the Western New York line, and a second spent as instructor in natural science at Wooster, Ohio, he returned to his college to share in its teaching, becoming an assistant professor in 1874. Two years later, in 1876, after spending a year under Helmholtz in Berlin he took office as the first professor of physics at the newly founded Johns Hopkins University. Baltimore remained his home until his death, on April 16, at the early age of fifty-three years.

His work at Berlin on the magnetic efforts due to a moving body when carrying an electric charge brought him at once into fame. The result was published by von Helmholtz in 1876, and is thus described by Maxwell in a metrical letter to Tait, written in June, 1877. Tait had inquired, also in verse, as to the electric effects to be expected if a disc of ebonite carrying a charge were made to rotate in its own plane, and Maxwell writes :

> The mounted disk of ebonite
> Has whirled before nor whirled in vain,
> Rowland of Troy, that doughty knight,
> Convection currents did obtain,
> In such a disk, of power to wheedle
> From its loved north the subtle needle.

Rowland showed by the direct effects produced on a magnetic needle that a charged body in motion gave rise to a magnetic field just as though it were a current whose strength depended on the product of the charge and the velocity.

This result is of fundamental importance to electrical theory; it was confirmed by Rowland and Hutchinson in 1889, and has been generally accepted as an established fact. Within the last few months, however, Cremieu has published an account of a repetition of Rowland's experiments which has led him to a negative result; the question just at the present moment appears to need further investigation.

Rowland's appointment at Baltimore was rapidly followed by a series of brilliant researches, each of the first importance. His determination of the unit of resistance came first. This was published in 1878. The original B.A. units were constructed by the Electrical Standards Committee in 1863-4 to represent $10^9$ C.G.S. units of resistance; according to Kohlrausch's results in 1870 they were 2 per cent. too high, while according to Lorenz (1873) they were 2 per cent. too low. Rowland's paper contains an able criticism of the old experiments and a detailed account of his own which led him to the number $\cdot9912 \times 10^9$ C.G.S. units as the value of the B.A. units. Further experiments in 1887 reduced this to $\cdot9864 \times 10^9$. The value now generally accepted is $\cdot98653 \times 10^9$. Rowland himself employed a modification of Kirchhoff's original method, in which the induction current in a secondary circuit produced by reversing a measured primary current in a neighbouring circuit is observed.

In 1879 Rowland presented to the American Academy of Arts and Sciences his paper on the mechanical equivalent of heat, with subsidiary experiments on the variation of the mercurial from the air thermometer, and on the variation of the specific heat of water. To attempt to give any account of the contents of this classic work would occupy too much space. To appreciate its value and to realise the skill and the ingenuity of its author it must be studied itself. More is known now about exact thermometry and the precautions necessary in using a mercury thermometer, and so it has come about that some corrections are necessary in Rowland's work, specially in that part of it which deals with the relation between the scales of the mercury and the air thermometer. These corrections were made at the Johns Hopkins University by Messrs. Day and Wardner and Mallory; but this fact detracts nothing from the importance of his investigation, and among the many determinations of the value of Joule's equivalent, Rowland's will always remain in the first rank.

Passing over, for the present, much work of great value, among which we may note his investigations into the magnetic permeability of various substances, published in the *Philosophical Magazine* for 1873 and 1874, and his theory of Hall's effect, we come next to the year 1882, when Rowland gave to the Physical Society of London an account of his concave grating. This is published in the *Philosophical Magazine* for September, 1883.

The results of this discovery are well known. A new weapon was placed in the hands of spectroscopists; it became possible to photograph spectra directly without the use of prisms or lenses, and with a greatly increased dispersion and resolving power; the beautiful maps issued at a later date by Rowland himself, and by Higgs of Liverpool, are striking evidences of the value of the grating; the additions to our knowledge arising from this one discovery are already enormous; much has been achieved which, without it, would have been impossible.

Rowland's own researches with his grating are summed up in his map of the solar spectrum and his table of the wave-lengths of the elements, published in 1893 (*Phil. Mag.*, July, 1893, reprinted from *Astronomy and Astro-Physics.*)

Of late years he gave much time and attention to a system of multiple telegraphy; this was shown working at the Paris Exhibition last year.

Enough has been written, perhaps, to indicate the debt physical science owes to Rowland; it is said he never received any regular instruction in physics; he was an engineer, and to this, in great measure, his success is due. The accuracy of his work on the ohm depends on the care he took to construct his induction coils so that their dimensions could be accurately measured; he dealt with the determination of the mechanical equivalent as an engineering problem; he employed a large mass of water and used steam power to rotate his paddle at a speed sufficient to make the resulting rise in temperature one that could be measured with accuracy.

The theory of the concave grating was his, but its success was due to the fact that Rowland had made an almost perfect screw; the method he employed in this in given in his article, "Screw," in the "Encyclopædia Britannica."

He lived for his work, but in his earlier days he was passionately fond of riding. Some years after the publication of the paper on the mechanical equivalent he was awarded a prize for it by one of the Italian Academies; about the same time he won a steeple chase, riding his own horse; he hardly knew which event gave him the greater pleasure. Another time, passing through England on his way home from the Continent, he had three days to spare. One of these was passed at Cambridge discussing electrical measurements, the other two were spent in a hurried visit to Exmoor to get a run with the staghounds. Twenty years ago he was a frequent visitor to England, and attended several of the meetings of the British Association; recently his visits were much less frequent. His friends here were aware that he was not well; some few weeks ago it was known that he had had a serious illness, but the news then was that he was better and on the road to recovery; however, an operation proved necessary, and he never recovered from its effects.

Thus within the last few months physical science is the poorer by the deaths of two of the most brilliant of the followers of Maxwell—Fitzgerald and Rowland; two who were foremost among those who have given to the theory of Faraday and Maxwell the right to claim the position of the theory of the electro-magnetic field.

R. T. G.

## *PROF. FRANÇOIS MARIE RAOULT.*

FRANÇOIS RAOULT, professor of chemistry at Grenoble, died there on April 1 after a short illness. In him France has lost one of her most distinguished men of science, whose discoveries have supplied material for theoretical considerations which, within the past fifteen years, have had a most profound influence on chemistry and physics.

Raoult was born on May 10, 1830, at Fournes (Nord). His father, an officer in the local customs' service of Villers Cotterêts (Aisne), sent the boy to school at Laon, with the intention of his afterwards entering Government service. But Raoult's tastes lay in a different direction; and with the full consent of his father he finished his school career at Paris, and entered the scholastic profession. He began his teaching career at the age of 23 in the Lycée at Reims, and was shortly afterwards transferred to the Collège of Saint Dié; while there he graduated as B. ès Lettres, and B. ès Sciences, passed his "Licencié" examination, and was appointed "Agrégé" of special secondary instruction. On presenting a thesis on "The Electromotive Forces of Voltaic Cells" he gained the title of "Docteur ès Sciences Physiques," and four years later, in 1870, he obtained the chair of chemistry at Grenoble, where he passed the rest of his life in constant labour in teaching and research during a period of 31 years. In 1889 he was elected "doyen," or dean of the faculty, and was re-elected to this important office four times. He occupied himself largely during the last dozen years in the reorganisation of the Faculty of Science, leading to the creation of a local university at Grenoble in 1896.

The author of this notice was once informed by Raoult that he independently discovered Faraday's and Ohm's laws; he had begun to experiment on the passage of electricity through solutions before he had acquired any real knowledge of what had already been achieved. On mentioning the fact to his scientific friends at Paris he learned, to his great disappointment, that his discoveries had been anticipated; but he took comfort in the thought that if he were able to make such discoveries, of which the importance is universally recognised, he must also be able to advance science in other directions. His first scientific work, published as his thesis for the doctorate, has already been mentioned; it was published in 1863, and until 1870 he devoted himself to a study of the chemical effects of the electric current, trying to distinguish between the heat evolved by chemical reactions and that due to the electric current in the voltaic cell. From 1870 to 1886 his attention was given to subjects of a more purely chemical nature, such as the extent of inversion of cane sugar under the influence of solar radiation; the absorption of ammonia by saline solutions; the presence of copper and zinc in the animal organism; the carbonates of calcium, strontium and barium; and the influence of carbonic anhydride on respiration. His work on the absorption of ammonia led him to consider the freezing-points of the saline solutions of that gas (1878); and from that date onwards he busied himself with the freezing- and boiling-points of solutions in water and in other solvents of salts and organic compounds, publishing his results in no less than 57 memoirs in various scientific journals. His last publication, "La cryoscopie," was published in the present year (*Collection Scientia*, Carré et Naud).

Most of Raoult's apparatus was constructed with his own hands; he was rather given to accurate experimentation than to the evolution of theories. The vast mass of evidence which he accumulated relative to the lowering of the freezing-points and of the vapour-pressures of solvents by the presence of dissolved substances made it possible for van 't Hoff to draw the important deductions relative to the connection of these phenomena with osmotic pressure and with the ionic theory of Arrhenius, which will ever shed lustre on his name. And to the practical chemist Raoult's work furnished a means of determining the molecular weights of non-volatile substances—methods familiar to every student of chemistry.

His labours met with ample, though tardy, recognition. In 1889 he was awarded the *Prix Lecaze*, of 10,000 francs; and in the same year he was made *correspondant de l'Institut de France*. In 1895 he received the biennial prize of the Institute; in 1892 he was the Davy medallist of the Royal Society, and in 1898 he was elected a Foreign Fellow of the Chemical Society of London. He was chosen *Chevalier de la Legion d'Honneur* in 1890, raised to *Officier* in 1895, and last year obtained the much-coveted title of *Commandeur*. He was a member of many foreign academies and scientific societies.

Though modest and retiring, Raoult's devotion to his work, dignity of character and sweetness of temper gained him many friends. He was not an ambitious

man, but was content to work on, happy if his discoveries contributed to the advancement of science. It is to the labours of such men that the progress of the world, both scientific and industrial, is due; for the methods which he introduced have led, not merely to a knowledge of the structure of many compounds which would otherwise have remained unknown, but have also had a profound influence on chemical theory, and have led to many discoveries of the utmost practical utility. He lived a happy and contented life, and even in his death his desire was satisfied; for in his discourse at the grave of his predecessor in the office of dean of the Faculty of Science at Grenoble, Lory, he gave utterance to the words:—"Puisque la mort est inévitable, ne vaut il pas mieux tomber ainsi tout entier, que de sentir la diminution lente et progressive de ses forces et de son intelligence?" Raoult died, after a few days' illness, without pain.

W. R.

## *DR. A. HIRSCH.*

INFORMATION has reached us from the president of the Council of State for the Republic and Canton of Neuchâtel of the death, at Neuchâtel on April 18, of Dr. Adolph Hirsch, aged 71, the director of the observatory at Neuchâtel since its foundation in 1859. Dr. Hirsch was also secretary to the International Committee of Weights and Measures, established at Paris under the Metric Convention of 1875.

Dr. Hirsch contributed largely to our knowledge astronomy and meteorology, his earlier papers on the former subject having appeared in Berlin and Vienna, and his later papers, particularly with reference to the establishment and position of the new observatory in the Neuchâtel *Bulletin*. ("Établissement de l'Observatoire à Neuchâtel," *Bul.* v. 1859-1861; "Recherchés sur des Pendules Astronomiques," *Bul.* v. 1859-1861; "Découverte de deux nouvelles petites planètes," *Bul.* v. 1859-1861; "Rélation des phénomènes météorologique avec la marche, des instruments magnétiques," *Bul.* vi.; "Influence des taches du Soleil sur la temperature de la Terre," 1877; Sur le passage de Venus," 1883, etc.). In more recent years Dr. Hirsch has been closely identified with the introduction of the metric system of weights and measures as an international system. He was a member of the original Commission International du Metre of 1872, of which the present eminent director of the Imperial Observatory, Dr. W. Foerster, and Dr. Von Lang, of the University of Vienna, were also members. On the establishment of the new International Committee of Weights and Measures in 1875, Dr. Hirsch became its secretary, a position which he filled until his death. A master in metrological science and a prince of secretaries, his loss will be deeply deplored by all whose opportunity it was to seek his valuable advice and to be guided by his profound experience.

## *NOTES.*

THE gentlemen's soiree of the Royal Society will be held next Wednesday, May 8. The ladies' conversazione will not be held this year, in consequence of the death of Queen Victoria.

THE position of affairs at Coopers Hill College is most unsatisfactory. We understand that the Members of Parliament who are interested in the higher education of the country had obtained permission to move the adjournment of the House in order to discuss the latest report on the management of this institution laid before Parliament by Lord George Hamilton, but that some M.P., presumably at the instigation of the India Office, which shuns inquiry, has "blocked" this permission. This proceeding, which, unfortunately, the rules of the House allows, is but another instance of the diminishing power of the private member and the increasing domination of the Government. Lord George Hamilton stated last week that he had asked the Universities of Oxford, Cambridge and London to nominate representatives on the Board of Visitors. When reconstituted the Board is to appoint a committee to hold an inquiry into the whole working of the College. This committee can do nothing to lessen the gravity of the recent action of the Board of Visitors in the matter of the dismissed teachers. They may, however, be able to secure some sort of recognition of the professoriate in the management and policy of the College, and some diminution of the absolute power of one individual, which has recently wrought such harm both at Coopers Hill in England and at the Leland Stanford University in America.

THE reality of the connection between rats and plague is prominently brought into notice by the issue of a circular by the Local Government Board, instructing the sanitary authorities of seaports to take precautions against the entrance of plague-infected rats into this country. On the arrival in port of a vessel upon which, during the voyage, plague or sickness suspected to be plague has occurred, measures are to be taken to secure the destruction of the rats on board the vessel, and to prevent them from reaching the shore. In the case of vessels that have come from places infected with plague, strict inquiry is to be made on their arrival in port as to mortality or sickness among rats during the voyage. In the event of rats on board any ship being found to be infected with plague, all parts of the vessel frequented by those animals are, so far as possible, to be disinfected. The authorities of seaport towns invaded by plague are advised to endeavour to secure the destruction of the rats in the town, not least those inhabiting the docks and quayside warehouses. In connection with these instructions, it is worth while to bear in mind that plague is not usually transmitted by the bite of a diseased rat, but by fleas living on such rats. Experiments have shown that a healthy rat will quickly contract plague if caged with a diseased rat infested with fleas, but will not do so if the diseased rat is free from fleas. Perfectly healthy rats harbour very few fleas and are very expert in removing them, but these insects are abundant on sick rats. After death, as the body becomes cold, the fleas leave the rat, and if they reach another rat or human being they may inoculate their new host with the bacilli of plague.

PROF. BROUARDEL, Dean of the Paris Faculty of Medicine, has announced that at the end of his present term of office—namely, in February 1902—he will not accept re-appointment.

THE Rev. James Chalmers, who is reported to have been murdered in New Guinea, with the Rev. O. F. Tomkins and twelve students, was known to many anthropologists, and made some noteworthy contributions to our knowledge of the natives of New Guinea, where he passed twenty-three years of his life. His death has often been reported before now, and there is always a possibility that rumours from New Guinea will prove to be untrue; but we fear that in this case the news will be confirmed.

THE founders' medal of the Royal Geographical Society has been awarded to the Duke of the Abruzzi for his expedition to Mount St. Elias and for Arctic exploration. Dr. A. Donaldson Smith has been awarded the patrons' medal for his African expeditions and the important scientific observations made in connection with them. Awards have also been made to Mr. Louis Bernacchi and Captain Colbech for their aid in the *Southern Cross* Antarctic expedition, and to Captain Cagni for his journey to 86° 33′ N., on the Duke of the Abruzzi's expedition.

WE are reminded by the *British Medical Journal* that on October 13 Prof. Rudolf Virchow will complete his 80th year, and preparations are already being made by his numerous friends and pupils to celebrate that interesting anniversary with appropriate pomp and circumstance. A committee has been formed for the purpose of collecting subscriptions, to be applied to the development of the Rudolf Virchow Stiftung, which was established for the furtherance of science in 1881. The president of the committee is Prof. Waldeyer, the distinguished anatomist of Berlin; the secretary is Prof. Posner.

THE committee appointed by the International Congress of Geologists in August last has, says *Science*, announced as the subject proposed for the Spendiaroff prize for 1903 "A Critical Review of the Methods of Classification of Rocks" (Revue critique des méthodes de classification des roches). The value of the prize is 456 roubles, or about 64*l*. Manuscripts should be addressed to M. Charles Barrois, secrétaire général du Congrès Géologique International, 62, Boulevard Saint Michel, Paris. At least two copies of papers submitted in competition are required, and they should be sent, at the latest, a year before the next session of the Congress in 1903.

THE erection of a memorial to the late Prof. Huxley in Ealing, where he was born and received his early education, is contemplated. On the initiative of the council of the Ealing Natural Science Society, a committee of those persons connected with the district who are interested in the project has been formed. The first meeting of this committee was held on March 29, when an executive committee was appointed with the Rev. Prof. G. Henslow as chairman. A bronze medallion portrait has been advocated for the central feature of the design, which may take the form of a simple mural tablet or of a more worthy monument, as funds are obtainable, while should that support be forthcoming for which its projectors hope, an annual grant or medal might also be founded. Subscription to the fund is not confined to residents in Ealing, and persons who may be desirous of assisting in the endeavour to show honour to the memory of Huxley in the place of his birth should communicate with the treasurer of the fund (Mr. T. Simpson, Fennymere, Castle Bar, Ealing), or with the secretary (Mr. B. B. Woodward, 120 The Grove, Ealing).

THE investigation of the Louisiana Gulf Coast, made by Prof. Beyer for the American Ornithological Association for the purpose of stationing wardens to protect the sea birds, shows that action was not taken a moment too soon. Prof. Beyer found that nearly all the breeding places of the birds had been destroyed by killing the birds themselves and taking their eggs. Not a trace of birds was found on either Brush or Caillou Islands, at one time the home of millions of sea fowl. The same was true of Calumet and Castelle Islands, on which every living thing had been killed. A few gulls and hens were found left on Timbalier Island, and there are said to be a few on Last Island, which, however, could not be visited on account of the severe weather. Wardens were appointed wherever birds were found, and the fishermen of the neighbourhood promised to co-operate with the wardens in preventing the killing of the birds in the breeding season and the stealing of eggs.

THE annual general meeting of the Zoological Society was held on Monday. In the report of the council, reference was made to the publication of the fifteenth volume of the Society's *Transactions*, consisting of a monograph of the genus Casuarius, by the Hon. Walter Rothschild. A new pheasantry was built during the past year, and is now tenanted by a full series of members of the pheasant family. The number of visitors to the Gardens in 1900 was 697,178, showing a slight increase over the corresponding number in the previous year. The number of animals living in the Society's Gardens at the end of December last was 2865, of which 758 were mammals, 1495 birds, and 612 reptiles and batrachians. Amongst the additions made during the past year thirty-one were specially commented upon as being of remarkable interest, and in most cases new to the Society's collection. The Duke of Bedford was re-elected president of the Society.

WE learn from the *Electrician* that, in response to the complaints of a number of leading shipping companies, including the White Star, Cunard and American Lines, the Board of Trade has instructed the Marconi Company to erect a signalling station on the mainland close to the Fastnet Rock, at the western extremity of Ireland. All vessels fitted with wireless transmitting apparatus will henceforth be able to report to the shore when many miles outside the Fastnet, and this will, of course, abolish the waste of time and labour caused by the necessity for incoming steamers to pass inside the Fastnet in order to report to Lloyd's station on the mainland.

THE deposits of salt at Salton, California, U.S.A., forms one of the sights of America. They occur in a depressed portion of the Colorado Desert, parts of which are as much as three hundred feet below sea-level. The deposits cover as much as a thousand acres, and the company in possession of the area has shipped from it annually about two thousand tons of salt. The salt is cut by means of a plough and is piled into heaps such as those shown in the accompanying illustration, reproduced from the *Scientific American*. Each plough harvests about seven hundred tons of salt per day. A singular characteristic of the bed is that the salt is being deposited daily by springs which run into the basin, and as the water evaporates it leaves behind a crust of almost pure sodium chloride, which ranges from ten to twenty inches in thickness over the area. Geographers will remember that the deposits occupy part of the area of the desert of California flooded to the extent of hundreds of square miles in 1892, when the Colorado River broke it barriers.

THE origin of coal and the extent to which the coalfields of Great Britain have been worked were the scientific questions dealt with by Mr. E. B. Wethered in his presidential address to the Cotteswold Naturalists' Field Club on April 23. It was pointed out that the extent of our present exportation of coal was not contemplated by the Royal Coal Commission in 1871. In 1867 the amount of coal exported was 10,233,135 tons, and it was thought that no considerable increase would take place, whereas nearly fifty-six million tons were exported in the year 1899, including about twelve million tons consumed by steamers engaged in foreign trade. In the matter of home consumption the Commissioners were remarkably correct, their estimate for 1899 being 162,400,000 tons, the actual figures being 164,284,757

tons. Mr. Wethered suggests that another Commission should be appointed to consider the probable duration of the coalfields. Another point on which information is required is as to what natural stores of coal are under the Secondary rocks, and at what depths. It is of national importance that this information should be obtained.

*Symons's Meteorological Magazine* for April contains what purports to be the first tables of the climate of Pemba ever published. They were taken by Mr. T. Burtt at Banani, during the years 1899 and 1900. The small island of Pemba forms, with Zanzibar, that portion of the British East Africa Protectorate nominally under the rule of the Sultan of Zanzibar, the position of Banani being approximately 5° 15′ S., 39° 43′ E. The temperature is of course very uniform, the mean of the monthly maxima being 83°·4 and of the minima 70°·8, the absolute maximum being 95° and the minimum 65°. The rainfall is copious, averaging about 98 inches. The two rainy seasons are well marked, the greater being March to May, and the less November to January.

MR. G. W. KIRKALDY has favoured us with a copy of his paper on the stridulating organs of water-bugs, recently published in the *Journal* of the Quekett Microscopical Club. The males of these insects, which alone produce the sounds, can mostly be referred to their proper species from the stridulating organs alone. Generally it seems that the sound is produced by drawing the comb-like structure situated on the tarsus of one leg across the femur of the other, and *vice versâ*. But it is believed that there is also a second musical area, one of the constituents, at least, of which is situated on the abdomen. Observations are needed as to the precise *modus operandi* of both types of stridulating organs in these insects.

THE *Biologisches Centralblatt* of April 1 contains the two concluding sections of Dr. C. Rengel's account of the life-history of the great black-water-beetle commonly known as *Hydrophilus piceus*. It is shown that, unlike those of the brown water-beetles (*Dytiscus*), which devour free-swimming creatures like tadpoles and the larvæ of other insects, the larvæ of the black water-beetle subsists on slow-moving organisms, especially pond-snails. In the earlier stages of their existence the larvæ devote their attention to Physa and the smaller kinds of Lymnæa, but when full grown they do not hesitate to attack the comparatively large *Planorbis corneus*. The idea that these larvæ always seek a hole in the ground in which to pupate is shown to be incorrect, the transformation having been observed to take place among a mass of weeds. It seems also that when a hole is selected, this is not excavated by the larvæ themselves. By an inadvertence the title of this paper occurs in the table of contents of the *Centralblatt* of April 15.

THE issue of the *Revue Scientifique* of April 20 contains the first instalment of an interesting article by M. Henri Coupin on the song of birds. The author commences by referring to the large proportion of tuneful species met with among the birds of Europe, which he sets at ten per cent., whereas in the tropics it falls as low as one per thousand. The gorgeous birds of the tropics he compares to actresses without talent, who depend for success on the richness of their toilets. Stress is then laid on the fact that, in spite of its simplicity, bird-song cannot be imitated by any known musical instruments. It is possible, indeed, to reproduce the pitch and intensity of the notes, but not the *timbre*, which includes such a multitude of sounds as to defy imitation. Indeed, the observations of M. F. Lescuyer have shown that although the notes of birds correspond to those of our musical scale, yet they also include a number of vibrations occupying the intervals between our notes, and it is this which renders imitation impossible. In most birds the duration of the song is very brief; in the thrush and the chaffinch it lasts only two or three seconds, in the blackcap from four to five seconds, and from two to five minutes in the lark. The author then proceeds to analyse the sounds constituting the songs of birds, and to distinguish between their songs and their alarm-cries.

WE have just received Part vii. of the bibliography of the more important contributions to American economic entomology, issued by the U.S. Department of Agriculture (Division of Entomology), extending from December 31, 1896, to January 1, 1900. This part, prepared under the direction of Prof. L. O. Howard, the entomologist, by his assistant, Mr. Nathan Banks, contains an alphabetical index, under authors' names, of 1383 papers in different American periodicals, and a subject-index extending to thirteen pages (double columns) in small type. The book is a good illustration of the energy with which economic entomology is pursued in the United States, where, however, it must be remembered that insects are much more numerous and destructive than in Europe, or at least in England.

THE issue of *Die Umschau* for April 20 contains a short illustrated article on the ship *Gauss*, which has been built for the German Antarctic Expedition. A photograph from a model and some views of the vessel in various stages of construction are reproduced.

DR. E. FRIEDRICH contributes a paper on the india-rubber production of Africa to the *Deutsche geographische Blätter*. The export statistics of twenty-five African colonies are dealt with, and the results exhibited graphically on a sketch-map, from which some interesting geographical conclusions are drawn.

THE *Verhandlungen* of the Berlin *Gesellschaft für Erdkunde* contain a brief abstract of a lecture, by Dr. K. Kretschmer, on the physical development of the North Sea coasts during historic times. The author refers specially to the regions near the mouths of the rivers Ems and Jade, and describes changes recorded by various authorities since Roman times.

WITH reference to Mr. T. W. Kingsmill's letter in last week's issue (p. 608), Prof. Haddon writes to say that he appreciates its value, but at the same time he wishes to disclaim any first-hand knowledge of Chinese authorities, and to remark that in his article he merely gave an account of M. Ujfalvy's views.

A VOLUME on the history of physiology during the sixteenth, seventeenth and eighteenth centuries, by Sir Michael Foster, will shortly be published in the Cambridge University Press Biological Series, edited by Mr. A. E. Shipley. The book will consist of lectures delivered by the author last autumn before the Cooper Medical College in San Francisco. Without claiming to be a complete history of the subject the book will contain a full account of the chief advances made in physiology from the time of Vesalius until the beginning of the nineteenth century. In the same series Prof. Marshall Ward is issuing a work on grasses on a somewhat novel plan. It is essentially a practical book, to be used in the field and in the laboratory, and should be of use, not only to the botanist, but also to the farmer and the gardener.

WE have received from Messrs. A. E. Staley and Co. a catalogue of microscopes manufactured by the well-known Bausch and Lomb Optical Co. of Rochester, New York, U.S.A. From the description of their works contained in the catalogue it is evident that the method of production is essentially American. Machine tools of the most modern description and specialisation of the manufacture of component parts should result in every article being of the highest class. The instruments listed of the so-called "Continental" type do not call for

special notice. Of the cheap stands, the American type microscope (F.) is undoubtedly of good design. The horse-shoe foot is replaced by one of a much more stable tripod form, and the arm carrying the tubes and adjustments is particularly well made, giving freedom all round the stage while securing a firm support for the body-tube. All the usual microscope accessories are listed, but there is nothing of such special design as to call for particular notice.

THE additions to the Zoological Society's Gardens during the past week include two Wild Swine (*Sus scrofa*, ♂ ♀), European, presented by H.M. the King; a Leopard (*Felis pardus*) from West Africa, presented by Captain Guy Burrows; an Eland (*Orias canna*, ♂) from South Africa, presented by the Duke of Bedford; two Grey-breasted Parrakeets (*Myopsittacus monachus*) from Monte Video, presented by Mrs. Brownrigg; two Ground Snakes (*Typhlops exocoeti*) from Christmas Island, presented by Sir John Murray, K.C.B., F.R.S.; a Grey-cheeked Mangabey (*Cercocebus albigena*) from West Africa, a Brazilian Tree Porcupine (*Sphingurus prehensilis*) from South America, two Black Tortoises (*Testudo nigra*) from the Galapagos Islands, three Dark Green Snakes (*Zamenis gemonensis*), two Smooth Snakes (*Coronella austriaca*), European, deposited; a Sambur Deer (*Cervus aristotelis*, ♂) from India, two Javan Peafowls (*Pavo spicifer*, ♂ ♀) from Java, two Peacock Pheasants (*Polyplectron chinquis*, ♂ ♀) from British Burmah, two Australian Sacred Ibises (*Ibis strictipennis*) from Australia, two Summer Ducks (*Æx sponsa* ♂ ♀) from North America, two Blood-breasted Pigeons (*Phlogaenas luzonica*) from the Philippine Islands, four Ruffs (*Machetes pugnax*, ♂ ♂, ♀ ♀), twelve Green Lizards (*Lacerta viridis*), European, purchased.

## OUR ASTRONOMICAL COLUMN.

COMET *a* (1901).—The Sydney correspondent of the *Times* reports that a brilliant comet was seen early on Tuesday morning (April 23) at various stations throughout the Australian continent. It was stated to have been near the star Aldebaran (α Tauri).

On Friday, the 26th ult., a telegram received from Dr. Gill announced that the new comet had been observed from the Cape Observatory. It was very brilliant, having a compound triple tail about 10° long. The comet was observed on the eastern horizon some two hours before sunrise and was rapidly approaching the sun, so that it may be expected to become more brilliant as perihelion is passed. It was seen by the observers at the Yerkes Observatory at Wisconsin early on Saturday morning last, about 15° north of the sun. This indicated that it had made a very rapid north-westerly movement in relation to its position when seen at the Cape. It was visible for fully twenty minutes before sunrise and about fifteen minutes after, and is considered the brightest comet seen for the last nineteen years. No account has yet been received of the comet having been seen in this country.

## THE APRIL METEORS OF 1901.

A SERIES of very clear nights enabled these objects to be looked for in favourable circumstances this year. Moreover, the moon was absent, so that the smaller class of meteors could be well seen projected on the dark blue of the cloudless sky. Meteors are usually very rare in April, and it is only the shower of Lyrids, occurring in past years on about the 20th, that has made the month interesting to meteoric observers. The display apparently returns annually, but it is often inconspicuous and rarely proves as rich as the August Perseids.

On April 13, 17, 18 and 19 I maintained a watch of the north-east region of sky, but found meteors scarce and there were very few Lyrids. The minor showers of the epoch gave little sign of their presence; in fact, meteoric apparitions were so few and far between that observers found their patience sorely tested. Prof. Herschel watched perseveringly at Slough on the nights of April 10, 13, 14, 15, 16 and 17, and, in the aggregate, only recorded twenty meteors in 8½ hours.

On April 20 at Bristol the sky was brilliantly clear, and I kept a look-out during about five hours of the period from 9h. 50m. to 15h. 30m, but observed only twenty-nine meteors. Not a single Lyrid was included amongst them, though several bright, swift-moving meteors fell from a bordering radiant at 261° + 36° in Hercules.

On April 21 the firmament was less favourable, but soon after commencing to watch at 9h. 45m. I found meteors extremely numerous. Several of the minor showers were very active, and the Lyrids formed a pretty rich display. During 3¼ hours' watching, up to 14h. (allowing for occasional interruptions by clouds), I counted fifty-two meteors, and of these there were twenty-five Lyrids from a radiant about 5 degrees in diameter with 270° + 33° as a centre. But while registering the observed paths of the meteors seen, many others must have eluded detection. The horary rate of meteoric apparitions for a continuous watch of the firmament by one observer would have been about 25 and the proportion of Lyrids 12. The figures represent rather an unusual display, though falling far short of the strength of the Perseids and some other periodical showers. It must be remembered, however, that at the epoch of the Lyrids meteors are generally very rare, and that the principal shower is itself sometimes very feeble, if not quite invisible.

The fact of the maximum being so definitely marked on April 21, while there was a comparative absence of Lyrids on April 19 and 20, shows that for some time in future we must expect these meteors on the former date. This is, no doubt, owing to 1900 not having been a leap year. And the shower appears to be a very fugitive, short-lived one, or it must have exhibited more decided traces on April 19 and 20. Though I saw no Lyrids whatever at Bristol on April 20, Prof. Herschel informs me that he observed 5 during the night.

Nearly all the Lyrids seen this year were accompanied with streaks; this feature was, indeed, as well shown as it usually is in the case of the Perseids, Orionids and Leonids. When the radiant was rather low on April 21, the apparent motions were estimated as slow and slowish; but in the later hours of the night, with increasing altitude of the radiant, the velocity appeared much swifter.

Some of the meteors from Lyra and other constellations were very interesting, and in the following list I have made a few selections in the hope that the objects may have been observed elsewhere, and that the requisite data may be obtained for computing their real paths in the air.

| | | | | From | | To | | |
|---|---|---|---|---|---|---|---|---|
| | h. | m. | Mag. | ° | ° | ° | ° | |
| April 21 ... | 10 | 9 | 1 | 278½ | +52 | 304 | +70 | Lyrid |
| | 10 | 41 | 3 | 202 | +40 | 213½ | + 7 | α-β Perseid |
| | 10 | 50 | 2 | 210 | +50 | 171 | +40 | Lyrid |
| | 10 | 59 | 2 | 218 | +52 | 255 | +75 | Virginid |
| | 11 | 23 | 1 | 70 | +57 | 88 | +50 | Cassiopeid |
| | 12 | 47 | 2 | 269 | +46 | 305 | +49 | Virginid |
| | 13 | 7 | 1 | 242 | +74 | 130 | +74 | Lyrid |

On April 20, at 10h. 35m., I noticed a brilliant double flash, caused probably by a large meteor at a low altitude, and hidden from my view by houses in this locality.

Two meteors appearing on April 18 were mutually observed at Slough and Bristol. The first was seen at 13h. 19m., and it fell from an altitude of 83 to 55 miles over Oxfordshire. The radiant was at 266° + 33°, so the meteor was an early Lyrid, and it having been well seen at both stations, the direction of its flight was recorded with considerable accuracy. The position of its radiant at 266° + 33°, as compared with the general Lyrid centre at 270° + 33° three nights later, on April 21, proves that this shower, like that of the August Perseids, exhibits a radiant moving eastwards at the rate of about one degree per day. The second meteor doubly observed was registered at 14h. 47m., and it descended from 58 to 44 miles over the borders of Gloucestershire and Oxfordshire. The radiant was at 247° ± 0°, so the meteor belonged to one of the minor showers of the epoch.

Since writing the above I have learnt that two bright meteors, the 1st and 5th in the above list, were observed by Mr. C. L. Brook at Meltham, near Huddersfield, as well as at Bristol. The first was a Lyrid with radiant at 268° + 30°, and it fell from 79 to 54 miles in height over the Midlands. Its length of path was 60 miles and velocity 40 miles per second. The other meteor was a Cassiopeid belonging to a radiant at 21° + 59°,

and falling from 66 to 44 miles over Merioneth and Cardigan, Wales. Its observed length of path was 55 miles and velocity 14 miles per second. It is remarkable that though few, if any, of the smaller class of shooting stars diverge from this radiant near δ Cassiopeiæ in the spring months it yet furnishes many fireballs. In the General Catalogue of Radiants, No. xv. p. 228, the radiants of five fireballs appearing in April and May give a mean centre at 20°+57°, which is almost identical with that of the bolide of April 21 last. W. F. DENNING.

## CHEMISTRY IN ITS RELATIONS TO ENGINEERING.[1]

THE engineer of fifty years ago can hardly be said to have received any special educational training; he forced himself to the front in virtue of his qualities and industry alone. But the youth who to-day intends to become an engineer feels it wise, if not necessary, to decide where he shall receive, not only his general, but also his engineering education. While he was at school he will have learnt much about the simpler and more general laws and facts of mechanics and natural science, both by description and by practical work in the laboratory and in the workshop; he will also have attained to some proficiency in mathematics, in one or more of the modern languages, in drawing and in other usual school subjects. When he passes on to his college career his knowledge of these subjects will undergo expansion in the class-room and especially in the laboratory and workshop. It is satisfactory to find that many of our leading schools for training engineers exist in connection with institutions in which pure and applied mathematics, natural science and modern languages are efficiently taught even in their higher stages. The engineering student is thus afforded the opportunity of following up the higher study of any one of these subjects, if his taste and energy lead him to wish him to do so. But even his ordinary course of instruction always includes the opportunity of obtaining lecture and laboratory instruction in chemistry.

### *Chemistry in Engineering Education.*

It appears to be the general feeling of those who have had experience in teaching chemistry to engineering students that it is useless to attempt very much in the small amount of time which can be allotted to the subject in the regular curriculum; it is evidently felt, however, that a student who wishes to attain to any considerable proficiency in the subject should be encouraged to join certain additional courses which are included in the ordinary chemical curriculum.

Probably all that can be expected of the average engineering student is that he shall become generally conversant, during his college course, with chemical language, with chemical principles and laws, and with the chemical nature of the materials with which he has to deal; and that he should obtain such an insight into chemical analysis as to be able to confer with the trained chemist, and to understand the meaning of a general statement of the results of chemical analyses bearing on metals, alloys, fuel, lubricants, cements and other materials which are frequently used by the engineer.

It is beyond question that the engineer has too many calls upon his time and energy, both in his training and in his subsequent career, to allow of his becoming a chemist or a chemical analyst; but he should at least be sufficiently conversant with the science to enable him to appreciate the important bearings of chemistry on his varied requirements, and to enable him to avail himself intelligently of the results of chemical investigation and analysis. He should be able to watch and to appreciate any chemical inquiry and investigation, even if he is not qualified to suggest its methods of procedure or to carry it out himself.

It has been stated to me by a German manager of large English works, who has frequently occasion to call in the professional advice and assistance of both engineers and chemists, and who is himself well educated in both departments, that he has to lament in this country the "absence of useful engineering knowledge among chemists, and of useful chemical knowledge among engineers." Another informant states that Germany employs many more trained chemists working in conjunction with her engineers than England does.

### *Applications of Chemistry to Engineering.*

In order to illustrate some of the advantages which engineers have derived from chemical coadjutors, one or two instances may be selected from different fields of engineering activity and enterprise.

In the matter of supplying the engineer with suitable constructive materials, the most striking case is that of the introduction of cheap steel of varying qualities in substitution for costly steel and other less suitable forms of iron.

The Bessemer process owed its original suggestion, as well as its salvation from failure, to the chemical knowledge which was supplied to those who were interested in the procedure. It further owed the extension of its application to all the commonest, cheapest and most abundant kinds of impure English cast iron to the further utilisation of chemical knowledge and suggestion.

At the present time the metallurgical chemist and the chemical metallurgist are engaged in furnishing metals and alloys, new to commerce, which can rank in importance with cheap steel, only in a somewhat minor degree; and the engineer in every department of his activity is now continually having placed at his disposal alloys which are more suitable for his various designs than any which he has hitherto employed.

It is scarcely necessary to point out the absolute necessity of chemical knowledge and chemical advice to the gas engineer. In the matter of water supply, also, both the engineer and the chemist find their respective but closely connected spheres of duty.

There is another direction in which the constant relation of chemistry to engineering, and in which the association of the chemist with the engineer must be maintained, if success is to be secured and expensive failures are to be avoided.

In no application of chemical and engineering principles is the co-operation of chemist and engineer more necessary for the attainment of success than in securing the suitable purification of our town sewage. Such co-operation has enabled London, Manchester and other large centres of population in recent years to carry out on an experimental scale most important trials of the natural or bacterial treatment of sewage, and has led to reports on this method being published which will probably become classical. This experimental work has led to considerable and valuable development and improvement of the bacterial method. There is now no doubt that this process can inexpensively dispose of a large proportion of the putrescible sediment or sewage-sludge, and can render the effluent, not only non-putrescible and suitable for maintaining the life of fish, but even pure if necessary. The process is therefore destined to effect great reforms in our sewage-disposal problem and considerable improvements in the condition of our watercourses.

[1] Abstract of the "James Forrest" lecture delivered at the Institution of Civil Engineers on April 25 by Prof. Frank Clowes.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Rede Lecturer for the present year is Dr. F. W. Maitland, Downing professor of law. Dr. Haddon, F.R.S., gives this term a course of lectures on studies in Papuan ethnology and the races of Oceania, on Mondays and Fridays at 2.30 p.m.

The Medical School Buildings Syndicate recommend the acceptance of tenders for the erection of the Downing Street wing and the Humphry Museum, amounting to more than 26,000*l*.

The Frank Smart studentship in botany at Caius College, of the annual value of 100*l*., will be vacant at Michaelmas. Candidates must have taken honours in Part i. of the Natural Sciences Tripos. Further information may be had from the senior tutor of the College.

A meeting was held in St. John's College on April 27 for the purpose of procuring a portrait of Prof. Liveing, F.R.S., as a memorial of his lifelong services to the University. The meeting was largely attended by members of the Senate, and a warm tribute was paid to the professor, who began his teaching of chemistry fifty years ago, and who during that time has in many ways, public and private, benefited the University, town, and county of Cambridge. A strong committee was formed to carry out the purpose of the meeting.

Prof. Newton announces that there are vacancies for workers at the University tables in the Plymouth and the Naples zoological stations. Applications are to be sent to him by May 23.

Twenty-one candidates have passed the half-yearly examination in sanitary science for the diploma in Public Health, held in April.

Dr. J. N. Langley, F.R.S., is re-appointed deputy-professor of physiology until Michaelmas 1903, in the place of Sir M. Foster, M.P.

MR. R. T. SMITH has been appointed principal of the Northern Polytechnic Institute. He organised and equipped the South African College, Capetown, and acted as professor of mathematics and physics in the College for several years; and, more recently, was lecturer in mathematics and physics in the Goldsmiths' Institute, New Cross.

THE Secretary of State for War has appointed a committee to consider the education of candidates for commissions in the Army and the system of training at Woolwich and Sandhurst, and to report whether any changes are desirable in the present methods of entrance into the Army. The following will form the committee:—The Right Hon. A. Akers-Douglas, M.P. (chairman); the Rev. Dr. Warre, headmaster of Eton; Mr. F. W. Walker, high master of St. Paul's School, Hammersmith; Colonel Jelf, C.M.G., Royal Engineers; Lieutenant-Colonel Hammersley, Lancashire Fusiliers; Captain Lee, M.P., late professor of strategy and tactics, Royal Military College, Canada; and Captain W. E. Cairnes, Royal Irish Fusiliers (secretary).

ADVOCATES of improvements in geometrical teaching will be glad to know that the Civil Service Commission has lately introduced a change of importance to all who are concerned with Civil Service examinations. Before this year an instruction at the head of examination papers in geometry stated that "Proofs other than Euclid's must not violate Euclid's sequence of propositions." Upon recent papers, however, this has been superseded by the note that "Correct demonstrations, whether those of Euclid or not, will be accepted." It thus becomes possible for teachers preparing pupils for the Civil Service to be independent of Euclid's sequence or proofs. Recent questions also encourage teaching of a less abstract character than that usually associated with Euclid's geometry. We understand that the Board of Education will accept alternative proofs of propositions in future examinations in geometry.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Physical Society**, April 26.—Dr. R. T. Glazebrook, foreign secretary, in the chair.—A paper on the thermodynamical correction of the gas thermometer was read by Prof. H. L. Callendar. This paper commences by giving a short historical sketch of the thermodynamic correction of the gas thermometer, describing some of the solutions to Thomson's fundamental equation for the Joule-Thomson plug experiment. The assumptions made in the solutions have sometimes been erroneous and wrong corrections have been obtained. From 1885 to 1888 Chappuis made a series of careful comparisons between various gas thermometers and a very delicate mercury thermometer, and drew up a table of differences between the hydrogen and the nitrogen thermometer. The author has taken the observations of Chappuis and calculated a new table of differences. The index "$n$" in the modified Joule-Thomson equation is not constant. For steam it is about 3·5 and for carbonic acid about 2. The thermodynamic correction is very small, especially in the case of hydrogen and helium, and is very much less than the correction for the expansion of the thermometer bulb. Prof. Herschell asked whether the co-volume came into the correction. Dr. Harker looked forward to the experiments which Prof. Callendar proposes to make with a constant pressure thermometer. The chairman expressed his interest in the extreme delicacy of the observations of Chappuis.—A paper on the production of a bright-line spectrum by anomalous dispersion and its application, the "flash-spectrum," by R. W. Wood, was read and experimentally illustrated by Mr. Watson. It has been suggested by W. H. Julius that the "flash-spectrum seen immediately at totality may be due to photosphere light abnormally refracted in the atmosphere of metallic vapours surrounding the sun. The light which will be thus abnormally refracted will be of wave-lengths almost identical with the wave-lengths which the metallic vapours are themselves capable of radiating. The sun is supposed to be surrounded by an atmosphere of metallic vapours, the refractive index of which decreases with increasing distance from the surface. In this atmosphere the rays of light coming from the photosphere move in curved paths. The refractive index is, however, very small, except for wave-lengths very near those absorbed by the vapour, consequently the light which resembles that emitted by the vapours, is most strongly refracted, and therefore curves sufficiently to reach us after the photosphere has been hidden by the moon. The flash-spectrum of sodium was shown by focussing the light of an arc lamp on a horizontal slit in front of a flat metal plate supported so that the plane in which its under-surface lay coincided with the plane of the slit. At a distance of about two metres a direct vision spectroscope was arranged to give a vertical spectrum and placed at such a height that the prism barely caught the rays coming from the slit and grazing the plate. On looking into the spectroscope a bright continuous spectrum is seen. A Bunsen burner was then placed underneath the metal plate and fed with sodium. This produced a layer of sodium vapour of varying refractive index. On raising or lowering the spectroscope bright sodium lines are seen due to anomalous dispersion. By arranging screens these lines can be obtained so that, on cutting out the arc lamp, the flash-spectrum vanishes. Prof. Herschel expressed his interest in the experiments and their application to the case of the flash-spectrum seen at totality.

### PARIS.

**Academy of Sciences**, April 22.—M. Fouqué in the chair.—On the residues and periods of double integrals of rational functions, by M. Émile Picard.—On an apparatus designed to move the photographic plate which received the image furnished by a siderostat, by M. G. Lippman. In an image given by a siderostat only one point is really fixed, the other points appearing to move round this with a variable velocity. It is shown that a suitable motion can be given to the photographic plate capable of overcoming this defect by means of a gear driven by the clockwork of the siderostat.—On the existence of nitrides, argonides, arsenides and iodides in crystalline rocks, by M. Armand Gautier. The finely powdered granites and basalts were decomposed by heating at 100° with phosphoric acid. Determinations are given of the amount of nitrogen, arsenic and iodine in various rocks.—Comparison of the work done by a muscle in sustaining and lifting a charge, by M. A. Chauveau.—On the propagation of discontinuities in a viscous fluid; extension of the law of Hugoniot, by M. P. Duhem.—On a question relating to a displacement of a figure of invariable size, by M. R. Bricard.—On entire functions of several variables and their modes of growth, by M. Émile Borel.—Some isotherms of ether between 100° and 206°, by M. Edouard Mack. The pressure of the ether vapour was balanced by a piston floating on a very viscous liquid, and the volume of the ether, which was completely surrounded by a mercury bath, was deduced from the motion of the piston.—Cryoscopic researches, by M. Paul Chroustchoff. An account of some of the precautions necessary in applying the platinum thermometer to the measurement of the lowering of the freezing-point of dilute solutions.—On a new system of ammeters and voltmeters independent of the intensity of their permanent magnets, by M. Pierre Weiss. In an instrument of the d'Arsonval type a decrease in the strength of the permanent magnet causes a decrease in the sensibility of the instrument; in instruments having a movable magnetic needle controlled by a permanent magnet the opposite is the case. If, in an instrument of the moving coil type, the coil carries a small piece of soft iron, these two effects may be made self-compensating. It was found possible to construct a galvanometer of this type in which the sensibility was practically invariable.—On the influence of self-induction upon spark spectra, by Mr. G. A. Hemsalech. Three photographs are given showing the progressive changes produced in the spark spectra of cobalt, lead and magnesium by an alteration in the self-induction of the spark circuit.—Periodic oscillations productions by the superposition of an alternating current on a continuous current in an electric arc, by M. E. Kœnig.—On an apparatus which imitates the effect of luminous fountains, by M. G. Trouvé.—On barium hydride, by M. Guntz. Barium hydride, the existence of which was first indicated by Winkler, has been obtained in a pure state and found to have the composition $BaH_2$. This compound is of remarkable stability; it can be slowly sublimed in a current of hydrogen at 1400° C. without decomposition. Heated in a current of nitrogen, barium nitride is formed.—The estimation of nitric acid in waters by means of stannous chloride, by M. H. Henriet. The fact discovered by Divers and Haga that nitrates react with stannous

chloride giving hydroxylamine chloride has been applied by the author to the quantitative determination of nitrates in potable waters.—The action of various alcohols upon some acetals of monovalent alcohols, by M. Marcel Delépine. — On three new alkaloids from tobacco, by MM. Amé Pictet and A. Rotschy. Further particulars of the physical and chemical properties of the three alkaloids nicoteine, nicotimine and nicotelline.—The action of phenylhydrazine and of hydrazine upon the two isomeric methyl butyrylacetylacetates, by M. Bongert. On paraoxyhydratropic acid, by M. J. Bougault.—Some new reactions of organometallic derivatives, by M. E. E. Blaise.—On a new base derived from glucose, by MM. L. Maquenne and E. Roux. The base, which is termed glucamine, is obtained by reducing glucosoxime with sodium amalgam.—Action of the alkylcyanacetic esters on the diazochlorides, by M. G. Favrel.—Reduction of the nitro-derivatives of the azoic colouring matters, by M. A. Rosenstiehl.—On two new acetylenic acids. Synthesis of caprylic and pelargonic acids, by MM. Ch. Moureu and R. Delange.—On the indoxylic origin of certain red colouring matters of urine, by M. L. Maillard.—The calculation of the results of milk analyses, by MM. Louise and Riquier.—Segmentation in the genus Trochus, by M. A. Robert.—Action of isotonic solutions of chlorides and of sugar on the eggs of *Rana fusca*, by Mme. Ronfeau-Luzeau.—The stimulation of nerve and muscle by waves of very short duration, by M. G. Weiss.—Action of alcohol upon the gastric secretion, by MM. Albert Frouin and M. Molinier. The increased secretion of the gastric juice caused by alcohol is shown experimentally not to be due, as has been usually supposed, to a direct local action, nor is it due to an effect produced upon the nerves of taste.—On the second fermentation of the wines of Champagne, by M. E. Manceau.—Apparatus for the exact measurement of the skeleton and of other organs giving a clear image in radiography, by M. G. Contremoulins.—On the origin and mode of formation of the Oolitic iron ore of Lorraine, by M. Stanislaus Meunier.

## DIARY OF SOCIETIES.

*THURSDAY*, MAY 2.

ROYAL SOCIETY, at 4.30.—On the Variation in Gradation of a Developed Photographic Image when impressed by Monochromatic Light of Different Wave Lengths: Sir W. de W. Abney, F.R.S.—Ellipsoidal Harmonic Analysis: Prof. G. H. Darwin, F.R.S.—On the Small Vertical Movements of a Stone laid on the Surface of the Ground: Horace Darwin.—On the Intimate Structure of Crystals. Part V. Cubic Crystals with Octahedral Cleavage; Prof. W. J. Sollas, F.R.S.

LINNEAN SOCIETY, at 8.—Studies in Heterogenesis: Prof. H. C. Bastian, F.R.S.

CHEMICAL SOCIETY, at 8.—The Synthetical Formation of Bridged-Rings. Part I. Some Derivatives of Bicyclopentane: Prof. W. H. Perkin, jun., F.R.S., and Dr. J. F. Thorpe.—Ballot for the Election of Fellows.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—An Instrument for Measuring the Permeability of Iron and Steel: C. G. Lamb and Miles Walker.—A Watt-Hour Meter: Frank Holden.

RÖNTGEN SOCIETY, at 8.—Some X-Ray Improvements: James Cadett.

*FRIDAY*, MAY 3.

ROYAL INSTITUTION, at 9.—Memory: C. Mercier.

SOCIETY OF ARTS, at 8.—Polyphase Electric Working: A. C. Eborall.

ANATOMICAL SOCIETY, at 4.—(*a*) Additional Notes on the Articulations between the Occipital Bone, Atlas, and Axis in the Mammalia: (*b*) On the Development of Digits in Cetacea; (*c*) Observations on the Development of the Human Brain before and after Birth: Prof. Symington.—A Contribution to the Study of the Morphology of Adipose Tissue: Dr. H. Batty Shaw.—A Lantern Demonstration showing the Origin and Nature of the Hydatiform Bodies of the Testicle and Broad Ligament, with Special Reference to the Fate of the Mullerian Duct in the Epididymis: J. H. Watson.—Relation of Structure to Function, as illustrated by the Growth of the Inferior Femoral Epiphysis: Prof. Arthur Thomson.

GEOLOGISTS' ASSOCIATION, at 8.—Geology and the Growth of London: A. Morley Davies.

*SATURDAY*, MAY 4.

ROYAL INSTITUTION, at 3.—Climate: its Causes and its Effects: J. Y. Buchanan, F.R.S.

*MONDAY*, MAY 6.

SOCIETY OF ARTS, at 8.—Alloys: Sir W. C. Roberts-Austen, K.C.B., F.R.S.

*TUESDAY*, MAY 7.

ROYAL INSTITUTION, at 3.—Cellular Physiology: Dr. A. Macfadyen.

SOCIETY OF ARTS, at 4.30.—The Coal Problem—its Relations to the Empire: Lieut. Carlyon W. Bellairs, R.N.

ZOOLOGICAL SOCIETY, at 8.30.—On the Spiders of the Family Attidæ found in Jamaica: Mr. G. W. Peckham and Mrs. E. G. Peckham.—On the Hymenoptera collected during the "Skeat Expedition" to the Malay Peninsula, 1899-1900: P. Cameron.—On the Arachnida collected during the "Skeat Expedition" to the Malay Peninsula, 1899-1900: M. Eug. Simon.

*WEDNESDAY*, MAY 8.

SOCIETY OF ARTS, at 8.—School Work in Relation to Business: Sir Joshua Fitch.

GEOLOGICAL SOCIETY, at 8.—The Influence of the Winds upon Climate during the Pleistocene Epoch: a Palæo-Meteorological Explanation of some Geological Problems: F. W. Harmer.

IRON AND STEEL INSTITUTE, at 10.30.—Annual Meeting.

*THURSDAY*, MAY 9.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 5.30.—(1) A Case of Algebraic Partitionment; (2) On the Series whose Terms are the Cubes and Higher Powers of the Binomial Coefficients: Major MacMahon, R.A., F.R.S.—A Property of Recurring Series: G. B. Mathews, F.R.S.—The Product of Two Spherical Surface Harmonic Functions: J. B. Dale.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Storage Batteries in Electric Power Stations, controlled by Reversible Boosters: J. S. Highfield.

IRON AND STEEL INSTITUTE, at 10.30.—Annual Meeting.

*FRIDAY*, MAY 10.

ROYAL INSTITUTION, at 9.—The Response of Inorganic Matter to Mechanical and Electrical Stimulus: Prof. J. C. Bose.

SOCIETY OF ARTS, at 8.—Polyphase Electric Working: Alfred C. Eborall.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

*SATURDAY*, MAY 11.

ROYAL INSTITUTION, at 3.—The Rise of Civilisation in Egypt: Prof. W. M. Flinders Petrie.

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