THURSDAY, NOVEMBER 12, 1908.

A HISTORY OF THE EARTH.

Geschichte der Erde und des Lebens. By J. Walther. Pp. iv+570; with 353 illustrations. (Leipzig: Von Veit and Co., 1908.) Price 14 marks.

PROF. WALTHER'S history of the earth and of life has been written with that combined knowledge of physical geography, stratigraphy, astronomy, and biology which we have learnt to expect from the author's previous writings. He tells the story of the earth in a series of chapters which have the interest of essays instead of the compressed information of a text-book, and are rich in fresh observations made by the author or culled from recent technical literature. The volume is remarkably well illustrated. One feature of the illustrations is the abundance of drawings showing extinct animals reproduced as in life. There are also numerous pictures of ideal landscapes and seascapes, drawn in accordance with most recent knowledge. Such, for example, is the terrifying picture of *Coccosteus decipiens*, by Rudloff, after a reproduction by Jaeckel, the beauty competition between Rhamphorhynchus and Archæopteryx on the shores of the Solenhofen lagoon, and the race between two flying Pteranodons, which, as they had a body weighing only 15 kilograms to a wing span of 18 feet, resemble a modern aëroplane with its small motor and vast sails. The views include pictures of life on the sea floor in two epochs of the Cambrian period, and one of a Calamite forest in the Carboniferous, by Rudloff, from designs by Walther. The illustration of Dinornis is, however, somewhat out of date, as the bird's title to its specific name of maximus is due more to the artist than to nature.

The book begins with a series of chapters on the physics of the earth, which the author describes as composed of five zones. For the central mass he adopts the name of pyrosphere, and to the zones usually accepted he adds the biosphere, which he separates from the underlying lithosphere, owing to the wide area occupied by coral limestones and forests. The author then discusses the relations of the earth to other heavenly bodies, and he enters a welcome and emphatic protest against the continuance of describing the ring-shaped mountains of the moon as volcanoes. He, however, accepts Dr. G. K. Gilbert's theory that they are due to meteoric masses which were fused by collision with the moon and spread out as a ring around the point of impact.

We also welcome his view, which he repeats from his paper of 1903, that the development of the deep oceanic basins began at the close of Palæozoic times, so that the modern abyssal oozes are not to be expected in the Palæozoic rocks. The book includes a map showing the supposed wanderings of the North Pole, and discusses the shifting of the pole as the possible cause of climatic changes; the fact is admitted, however, that this movement of the pole has not been proved for any geological period.

The author also refers to various attempts to express geological time in years, and in this matter does not seem very hopeful of satisfactory results. He quotes estimates of the age of the earth, from the 20 million years of Lord Kelvin to the 100 to 180 million estimate of Sir Archibald Geikie. He caricatures one line of argument by remarking that because one man can build a wall in 100 hours, it does not follow that 360,000 builders could build the same wall in one second. He gives a photograph of a lump of coral 8 centimetres high, which had grown in four years on a telegraph cable, and he argues therefrom that a layer of coral limestone 600 metres thick could have been deposited in 30,000 years, an unconvincing argument, owing to the difference in texture between a branching coral and a massive coral rock.

The section of the work devoted to stratigraphical geology the author calls "Bathrologie," which describes each geological system in reference to its most striking geographical character, such as the great northland of the Old Red Sandstone, the *Productus* Sea of the Carboniferous, the continent of Gondwanaland, the Triassic Sea and its struggle with the northern deserts, the Jurassic Sea, &c.

In his geological classification the author adopts one view which will probably not meet with general acceptance, for he groups together the Algonkian and the Cambrian as one group, the Urzeit; the systems from the Silurian to the Permian inclusive he calls the Alt-zeit. Considering the great unconformity and complete palæontological difference between the Algonkian and the Cambrian, and the uncertainty as to the dividing-line between the Cambrian and the Ordovician, the separation of the Cambrian from the rest of the Palæozoic is unnecessary.

In his interesting chapter on prehistoric man the author figures some eoliths from the Miocene; he regards these stones as showing artificial workmanship, and remarks that they have not been found associated with broken bones or any other signs of the contemporary existence of man. The author is probably only logical in his conclusion that, if the eoliths are of human origin, then the age of man must be extended back at least to the Miocene, and probably to even much earlier geological periods.

One mistake may be noted, as it has occurred in other text-books. On p. 132 it is stated that the Pink and White Terraces of New Zealand were destroyed by an earthquake, whereas they were blown to fragments by a volcanic explosion that left a vast crater deep below their site. J. W. G.

SCIENCE AND THE DAILY PRESS.

From an Easy Chair. By Sir E. Ray Lankester, K.C.B., F.R.S. Pp. viii+144. (London: A. Constable and Co., Ltd., 1908.) Price 1s. net.

SCIENCE renders the people a three-fold service. The increase in material comfort and in facility of communication which have resulted from ability to direct the forces of nature have been sufficiently proclaimed by public speakers and acclaimed by their hearers. It is less clear that the public recognise the

more important service rendered by the army of trained men of science, which wages ceaseless war against pestilence, flood, and famine. The scouts of this army penetrate the unknown, under conditions making no small demands on their courage, and render possible the advance of humanity. But even if sufficient regard be paid by the ordinary intelligent citizen to the material service done him by science, it can hardly be denied that he has no conception of his indebtedness on the intellectual and moral side. Yet scientific method, whenever and wherever made welcome, has imparted greater freedom and clearness of thought, has widened imagination and sympathy, and has led to a truer perception of life and character based upon concepts of law and order. Nor need we regard as a small matter the sum of intellectual enjoyment and stimulus derived from the progress of discovery. This progress would be quickened if the people met the demand of science for intelligent sympathy with its aims and methods; for active and liberal support of investigation; for national and personal action in respectful accord with the results established by investigators accredited by their fellow-workers.

But even the material benefits can be reaped to the full only by a nation prepared to recognise the truth expressed on p. 29 of Sir Ray Lankester's book:—

"Science is no handmaiden, but in reality the master—the master who must be obeyed. The sooner and the more thoroughly the people of this country recognise this fact, and insist upon its acceptance in practice by their representatives and governors, the better for them and their posterity."

To the present writer it appears that our fitness to remain at the head of a great empire depends upon our power to "recognise this fact."

Have we this power to-day? We have not; we must seek it through the intelligent sympathy of the people. The publication of this little book suggests one means—a powerful one—to our end, viz. the publication in the daily newspapers of information and articles of a truly scientific character. These articles or notes must be written by men of wide scientific knowledge and high attainments, in order that they may be accurate and reflect truly the aims, methods and results of scientific work.

In his preface Sir Ray Lankester explains that his book is a reproduction of articles which appeared in the *Daily Telegraph* from October, 1907, to April, 1908. The author's style is clear and animated, well adapted to arrest and hold the attention of the newspaper reader. The articles relating to tropical diseases, the public estimate of the value of science, heredity, ignorance, and vivisection display a power and earnestness suited to their themes. The lighter articles convey a considerable amount of information in a chatty, reminiscent style, interspersed with biographical detail. The bit of autobiography on p. 59 is a charmingly told illustration of the experimental method. When discussing votes for women our author is less illuminating, and is perhaps as likely to make opponents as converts. We are glad that he did not confine himself to biological subjects. He concludes an effective short statement of the problems connected with the orientation of ancient temples by a remark on Stonehenge which will be echoed by readers of NATURE:—

"The delay in examining everything on the spot and in making all that remains absolutely secure is a national disgrace."

We hope that the present volume will have many successors.

With the exception of Sir Ray Lankester's work and certain technical articles, the "scientific" paragraphs which we have read in the daily Press are far from reaching the standard which we have already indicated (or the standard reached, *e.g.*, in the case of musical criticism). Too frequently they fall to the level of burlesque absurdity—stuff which no editor would dream of publishing as serious information in regard to any other department of news. In addition to hearing the professor talk "from an easy chair," we want accurate statements of recent advances, as clear and simple as possible, relying for interest on intrinsic importance and not on "popular" dressing and sensationalism. Nor would such "news from the front" of the progress of our scientific army lack appreciative readers. The spread of scientific teaching in our schools and universities, the existence of fifty thousand members of our polytechnics, and, above all, the attention to scientific inventions which is a necessity to organisers of commercial and industrial undertakings—these guarantee the existence of a reading public able to appreciate such scientific information. Surely the time is ripe for the editors of our "dailies" to take science seriously. To find and harness a Huxley and a Helmholtz may be beyond editorial power, but it is within that power to employ men of high scientific training and to require from them contributions of first-rate quality. By so doing they would give an impulse to national progress in science. G. F. D.

THE GREAT PYRAMID.

The Great Pyramid of Gizeh; its Riddle Read, its Secret Metrology Fully Revealed as the Origin of British Measures. By M. W. H. Lombe Brooke. Pp. 217. (London: Banks and Son, 1908.) Price 7*s.* 6*d.* net.

THE mind of the gnostic is ever with us; it delights in founding the most far-reaching statements upon a basis of facts and dogmas which may or may not be true, but the relevance of which to the conclusion escapes the ordinary intellect. In this volume of 217 pages we have some fresh theories based on older ones about the Great Pyramid, but with a wide departure in results from those of the earlier theorists. Whatever we may conclude about the theoretical results of the late Prof. Piazzi Smyth, we all know that he was able to handle his material in a scientific fashion. This is far from the case in the present volume.

As examples of method we have (p. 29) a stone of most extreme irregularity—a natural boulder surface—stated to nine places of figures in its cubic

contents; a thickness of stone doubled (for no reason) and multiplied by the power or logarithm of another quantity to get a lineal quantity; a series of different breadths in inches added together (p. 178) ×10, compared with the number of theoretic pounds in a theoretic ton; or the number of lineal inches in a dimension (p. 187) shown to be the same as the number of grains in a theoretic cubic inch of an arbitrary specific gravity. No rational sense can be attached to such processes; they are numerical coincidences, and can have no meaning. When a very large number of quantities, of multipliers, and of processes of connection can thus be handled, and a wide latitude is allowed for the exactitude of the results, there is no reason for the product ceasing at 217 pages; it might as easily be continued to infinity.

The starting point is the boss of granite—one of the well-known lugs for stone lifting, the remains of many of which may be seen on other stones in the pyramid. The dimensions of this vary from 4·7 to 5·2 inches wide, and 0·94 to 1·1 inches thick, the faces being roughly hammer-dressed. This is then assumed to be exactly five inches wide and an inch thick. It is then assumed that at its junction with the stone face it is 7×5 inches; though rounded at the top, it is assumed to be rectangular, and an assumed unit of thirty-five cubic inches is deduced, and then used as a basis for pages of subsequent theory. Any one of the certainly wrong assumptions that are made would leave the conclusion entirely in air. But it serves as an efficient basis for an elaborate gnosis, interesting as a revelation of mental method.

Matters unknown to the author are also elaborated. We read of "those most exact and artistically prepared corner sockets," which are really vague and irregular in every part except the truly flat floor. The cubic content of a socket, which is sunk in a wavy, irregular surface of natural rock, is calculated, and, ÷2, the cubic inches equal the lineal inches in a theoretic mile. The faces of the pyramid are assumed to be concave in order to fill up the corners of the rock-cut sockets, and many pages of theory result from this assumption; yet at the north-east corner the drawn line of the base can be seen running some inches within the side of the socket, showing that the face was straight.

Not only does such wishing serve instead of facts to the gnostic mind, but it may entirely obliterate facts. We read, p. 17, of "the introduction of the French metric system with complete subversion and abandonment of all our hereditary measures." Yet, strange to say, the old English mile is two kilometres, the furlong 200 metres, the chain 20 metres, and the fathom two metres, or building yard one metre, within the small uncertainty of our knowledge; and this system is based on a foot, which was not only known widely in the north back to Roman times, but was known to foreigners in Egypt for thousands of years earlier. It is curious that the metric system was thus closely anticipated, and it is exactly contrary to our author's statements.

Points at issue might be raised innumerably, but it would be useless to do so. The type of mind that is nourished by such material transcends the usual limits of facts and proofs, and remains for us as one of the interesting specimens in the museum of psychology. W. M. F. P.

THE ANTHRACITE OF SOUTH WALES.

The Coals of South Wales, with Special Reference to the Origin and Distribution of Anthracite. By Aubrey Strahan and W. Pollard. Pp. vi+78. Memoirs of the Geological Survey of England and Wales. (London: H.M. Stationery Office, 1908.) Price 1*s.* 6*d.*

THIS memoir gives the results of an investigation into the character of the coals of South Wales. The collection of the material was begun in 1901, and the work has now so far progressed as to lead to an opinion as to the relative distribution of anthracitic and bituminous coals, and as to the origin of the difference between them. The results published include not only the analyses made for the purposes of the investigation by Mr. Pollard, Mr. E. G. Radley and Mr. C. A. Seyler, but also all previous trustworthy analyses of coal from recognisable seams. The total number of analyses is 203. In each case the particulars given include the local name of the seam, the colliery, the authority, the percentages of carbon, hydrogen, oxygen and nitrogen, the ratio of carbon to hydrogen, the percentages of volatile matter, and ash, the specific gravity, and the fuel ratio or the relation of fixed carbonaceous residue to volatile matter.

In view of the importance of considering the analyses of each seam separately, it was necessary to correlate, so far as possible, the seams of one part of the coalfield with those of another. The sequence of the seams has consequently received careful attention, and a plate of sections is given showing the position and correlation of the seams. The different bands of the same seam are compared, and the results are given of a comparison of different samples from the same seam in the same locality, as well as of different seams in the same locality. Other chapters deal with the analytical methods employed, with the accuracy of coal analyses and with the classification of coals.

Of the ten plates accompanying the memoir, five are iso-anthracitic charts designed to show areas of equal anthracitism in each seam or group of seams. The degree of anthracitism of each sample is expressed by the factor representing the relation of carbon to hydrogen. Among previous investigators there is a general agreement that the anthracitic character of the coals in part of the coalfield has resulted from a change effected upon coals which had been originally bituminous. Three explanations of the change have been put forward:—(1) that the anthracitic seams have been more deeply buried and consequently exposed to a higher temperature; (2) that they have been altered by adjacent plutonic rocks; and (3) that they are more affected by slip-cleavage. To these three theories there are serious

objections, and the investigations now recorded tend to show (1) that the seams are not all similarly anthracitic, and though each seam is generally more anthracitic than the one above it, there are many exceptions to the rule; (2) that the anthracitic character was not due to faults, but existed before the faults were formed; (3) that the anthracite existed as such before the coalfield was reduced by denudation to its present dimensions; and (4) that the percentage of ash diminishes *pari passu* with the decrease of bituminous matter. These conclusions point to the variations in the composition of the coals having been either original or at least of very early date. Indeed, of all the suggested causes of alteration subsequent to deposition, none appear to have been adequate to produce more than a slight modification of the differences due to original composition.

Written in faultless literary style and edited with scrupulous accuracy, this valuable addition to geological literature will appeal to a wide circle of readers, and the authors deserve great credit for the success they have achieved in the first attempt to define the distribution of anthracite and to explain its origin on purely experimental grounds.

VITALISM.

Versuch einer Begründung der Deszendenztheorie. By Prof. Karl Camillo Schneider. Pp. viii+132. (Jena: G. Fischer, 1908.) Price 3 marks.

A COUPLE of years ago Prof. K. C. Schneider published six admirably clear and objective lectures as an introduction to the study of the evolution-theory. It was a useful exposition of the facts of variation and heredity, and of the Darwinian and Lamarckian interpretations. The present volume is critical and personal, and is not easy reading. We cannot do more than indicate the author's point of view. The first half of the book deals with stimulus, psyche and consciousness, subject and individuation, sensation and heredity, need and purpose, and Darwinism. The second half deals with mutation, potency, and structure; orthogenesis and extinction; trophic stimulus; vitality; entelechy and heritability; phylogeny, and the becoming of man.

The author's general position is closely akin to the positivism of Mach and Avenarius, which is, he thinks, the stable foundation for that part of the biological edifice that now requires building. Biologically he is perhaps nearest Weismann, but he believes that the psychical is the most important biological factor; he will not hear of the transmission of somatic modifications, but he believes that the transmigration of souls is almost self-evident. In discussing Lamarckism he points out that it has two sides; on the one hand, it is an erroneous theory of passive transformation conditioned by external stimulus; on the other hand, it is a true theory of the subjective response of a creative agent. He develops this second idea—which he calls by the extraordinary name of "Eulamarckism."

Prof. Schneider is a neo-vitalist who has the courage to say out and out that he believes in a specific vital energy, in a living substance. There are some who deny this, and maintain that life may be described as a succession of fermentations and the like, but this view ignores the phenomena of regulation and correlation, not to speak of memory and the power of profiting by experience. There are others who deny a living substance, and refer regulation and mental processes to an immaterial principle or agent, which deals directively with metabolism, though it is not of it. Schneider does not sympathise with either of these positions; he supposes a special vital substance, the vehicle of the specific vital energy, just as the ether is the medium for radiant energy. But this vital substance is not a particular kind of matter; it consists of psychical substances residing in the structural units of the organism. The relation between Psyche and Physis is illustrated by the mutual relations in thermochemical processes. The physical processes in the plasma, which are set going by stimuli, correspond to the chemical processes; the associated psychical energy corresponds to heat. On the one hand there is molecular movement, on the other there is cell-sensation. Life depends on the sensations of cells, as heat on the movements of molecules. As temperature is the intensity-factor of heat, structure is the intensity-factor of vitality, the measure of vital potency.

In a short notice it would not be for edification to try to expound the author's views on the four-dimensional character of consciousness or the law of the conservation of the psyche, or his theory that the mysterious process of assimilation represents a particular kind of gravitation, and that the psychical analogue of the force of cohesion is the entelechy or soul—the formative principle of the organism.

Prof. Schneider believes strongly in mutation, but the essential factor in species-formation is "*Descension*"—which means a thorough-going change in organisation, such as getting a notochord or gill-clefts. To study descensions is at present the most urgent task of ætiologists. What brings about a "Descension"? It is a step in the "entelechialen (synthetischen) Umprägung" which seems to be the most characteristic secret of the organism.

J. A. T.

OUR BOOK SHELF.

Arithmétique graphique. Les Espaces arithmétiques; leurs Transformations. By Gabriel Arnoux. Pp. xii+84. (Paris: Gauthier-Villars, 1908.) Price 3 francs.

THE title of this little work does not indicate, as the English reader might expect, another addition to the ever-growing list of treatises upon geometrical methods of calculation or the graphical solution of ordinary problems. It might rather be described as an essay upon the geometrical interpretation of the theory of numbers.

The author has attempted a systematic exposition of what may be called the geometry of abacs and magic squares. By an *arithmetical space* he understands the set of all points (in a geometrical space of any number of dimensions) the coordinates of which are integral, and he has worked out the properties of such point-systems. Many theorems true for con-

tinuous space hold unchanged for such a discontinuous space. Some operations, however, such as rotation and transformation of coordinates to new axes inclined to the original ones, are possible only in certain cases. The study of the conditions under which such operations are possible, and of the effect of these operations when the conditions are satisfied, forms the main drift of the book.

The most interesting chapters are those which deal with what the author calls *modular* spaces. A modular plane space of modulus m is a square of m^2 points, a point (a, b) of this square representing all points $(a+pm, b+qm)$ of the unlimited arithmetical space, p, q being arbitrary integers. Geometrical properties of the complete unlimited space yield corresponding properties of the fundamental modular square, the coordinates of the original points being replaced by their *congruent* numbers of modulus m.

Transformations of coordinates in such modular spaces lead to the construction of magic squares and abacs.

Graphical methods are given for the solution of diophantine equations, and the last chapter deals with a number of problems, among them the following, originally proposed by Euler; from each of six different regiments six officers of different rank are taken. The problem is to arrange them in a solid square so that in each row and in each column there shall not be two officers of the same rank or of the same regiment. This problem, which was shown to be insoluble by MM. G. and H. Tarry in the case of thirty-six officers, is soluble when there are sixteen, and the reasons for this are here discussed.

Strangely enough, this branch of mathematics, although it might well be classed amongst the purest of the pure, is not without its industrial applications, notably in the weaving of tissues and fabrics.

Altogether, we commend M. Arnoux's book to those interested in the mathematical curiosities of the theory of numbers.

L. N. G. FILON.

Contributions to the Study of the Early Development and Imbedding of the Human Ovum. By Dr. T. H. Bryce, Dr. J. H. Teacher, and J. M. M. Kerr. Pp. viii+93; 10 plates. (Glasgow: J. MacLehose and Sons, 1908.) Price 12*s.* 6*d.* net.

IT will be a glad day for the science of embryology when all the details of the sequence of the development of man are described from successive stages of the human ovum and embryo. The chick has, to a great measure, passed from the position that once it occupied, and even the lower mammals cannot be taken as substitutes for human material, when human development is to be rightly studied. Much that is confusing in embryology to-day is the outcome of reading whole pages of the embryonic life-histories of other creatures into the early chapters of human development.

In certain special directions the primates form a group distinguished developmentally from other mammals, and man and the anthropoids differ in some details from the other primates. Our knowledge of the development of man will, therefore, not be ideal until all our stages are accurately described from purely human material. Towards the attaining of this ideal, the description of the Teacher-Bryce ovum materially helps; at the same time, it probably holds out a guarantee for the further extension of our knowledge of the earliest stages of human development, for the material so carefully treated in this case is material that is often neglected.

The Teacher-Bryce ovum is the earliest human ovum yet described—its age is computed at thirteen to fourteen days—and, owing to the care taken in ascertaining the details of its history, this computation may be taken as final.

It is younger, by probably a day, than the well-known ovum of Hubert Peters, described in 1899, although that ovum was originally considered to be no more than three to four days old.

Great care and a wealth of detail have been used in making the account of this ovum as complete as possible, and in order to render the material of more value, a table of all the recorded early human ova has been incorporated for comparative purposes.

The volume in which this ovum is described also contains the description of an early ovarian pregnancy, and this—like the uterine ovum—is the earliest stage that has yet been described.

It is but natural that, in dealing with such material, many new details should come to light, and all the many points of novelty receive very ample discussion and illustration. The whole technic of the work, and especially the many fine illustrations, mark a distinct advance on the ordinary run of English scientific publications, and towards this perfection the authors have to thank the Carnegie Trust for assistance. Dr. Bryce has already demonstrated his specimens at the meetings of scientific societies, and the general features of his early ovum are now well known to embryologists, but the book in which he describes it contains, apart from the mere description, a vast amount of well-assorted detail, got together and presented in most workmanlike fashion.

Graphic Algebra. By Dr. Arthur Schultze. Pp. viii+93. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 4*s.* 6*d.*

IN this text-book the author first gives examples of plotting from physical and statistical data, and the graphing of simple functions of one and two variables. He then proceeds to the main purpose of the book, which is that of solving algebraical equations by the use of squared paper and a few standard curves. Equations up to the fourth degree are fully dealt with, and, in order to facilitate the work, a method is cleverly developed in which the direct graph is replaced by two loci of a simpler nature, the intersections of which give the required roots. Thus a quadratic equation is solved by reading off the intersection of a standard parabola and a straight line; the same parabola is used for all quadratics, and it is only the scale and the position of the line which vary. Instead of the parabola, a rectangular hyperbola may be used. Cubics are dealt with by means of the curve $y=x^3$ and a suitable straight line. Biquadratic equations are solved by the intersection of a circle and the standard parabola or standard hyperbola. In all cases it is shown how to find the imaginary or complex roots, if such exist.

The whole subject is treated in a very concise and interesting manner, and the reader should become fully conversant with the principles of graphing and the nature of algebraical equations. But the special methods, however ingenious, must be regarded rather in the nature of mathematical exercises than as having any very useful practical applications, for such equations occur so seldom outside text-books that when an actual case does arise, simple direct methods of solution are usually to be preferred. This admirable manual concludes with an appendix containing some "statistical data suitable for graphic representation," a short table of squares, cubes, square roots, and reciprocals of numbers, and a collection of answers to the many exercises which are provided throughout the text.

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.

The Origin of Advent, and other Three Weeks' Celebrations.

FROM a series of measurements of solstitial monuments in Cornwall and Wales, Sir Norman Lockyer has advanced the theory that such monuments were erected, not so much to mark the exact solstice, as to give ample warning of that phenomenon. I have suggested from evidence in connection with fairs that the period of warning was three weeks, and Mr. W. E. Rolston finds measurements of three solstitial alignments, two at Tregaseal and one at Longstone, marking sunrise three weeks before the solstice.

When we come to think of it, marking the exact solstice sunrise must have been a difficult task. For three weeks or so, the sun's declination at the solstice is within one degree. Though the apparent stand-stillness of the sun at that point must have greatly impressed people from the earliest period, yet the Irish bard Amairgen could still boast :—

"Who teaches the spot where the sun rests (but I)?"

The astronomical three weeks' warning referred to seems to me to be the origin of our Christian Advent and Lent. What was intended as an astronomical warning of the solstice became, or most likely was from the first, a period of preparation for a great festival.

As to Advent, Daniel observes :—"The name Advent does not appear to have come into general use until long after the setting apart of the season which it designates, and the Greek Church to this day has no corresponding name for it" ("The Prayer-Book," p. 197). The season seems to be at first strictly limited to three Sundays, as the Bobbio Missal gives only three masses *in Adventu Domini* (Duchesne, "Christian Worship," p. 158). The commencement of the Advent season is associated with St. Andrew's Day, November 30, three weeks before the solstice.

The origin, use, and length of Lent have been similarly affected by Christian usage. Duchesne says that "at Rome it was the custom to observe the (Lenten) fast for only the last three weeks before Easter" (p. 243). "There were, however, Churches in which, up to the fifth century, Lent consisted of only three weeks of fasting" (p. 244). The inference is irresistible, that before Lent was made dependent on a movable Easter, it was a period of warning and preparation for a great solar festival.

But the question arises, Was the three weeks' interval measured from the exact date of the festival it led up to, or was it simply obtained by dividing the time between a May-year festival and a solstitial or an equinoctial one?

St. Andrew's Day, November 30, is mid-way between the astronomical Hallowe'en (November 8) and the winter solstice. At Llangefni, Anglesey, that whole period of six weeks, roughly, has been observed by six weekly fairs. The forty days of Lent is, of course, a similar arrangement for celebrating the whole period between a May-year festival and a solstitial one.

But it is to be noted, by the early observance of both Advent and Lent, that the last three weeks were of chief importance. At Magor, Mon., three weekly fairs used to be held immediately before Easter, a circumstance somewhat incompatible with the purpose of the Christian Lent, which, however, may be regarded as a curve in the evolution of Lent.

The calendar seems to be responsible for some displacement of the original three weeks' interval. Thus there are fairs held at Llanerchymedd, Anglesey, on the three first Wednesdays after November 13, or Old All Hallows.

To answer the question I have put, we must first consider the yearly course of the sun as divided into sixteen equal parts, or rough three-weeks' units, as follows :—

January 14.	May 6 M.	September 23 S.
February 4 M.	May 29.	October 16.
February 27.	June 22 S.	November 8 M.
March 21 S.	July 16.	November 30.
April 12.	August 8 M.	December 23 S.
	September 1.	

M = May-year, S = Solstitial-year.

Treating Lent as originally a warning of the vernal equinox, if not of the February festival, I begin with the May-day warning. I note four fairs held on April 15, exactly twenty-one days before the astronomical May-day, May 6, while the dividing point of the sun's course between the vernal equinox and May 6 is April 12, so the three weeks were counted as from May-day. The places are Ystradgynlais, Carmarthen, Penmark, and Penderyn. At three other places the fairs are held on April 16, namely, Aberdaw, Llangathen, and Devynnock.

That April 15 has reference to May 6 is fairly certain, because of the persistence, in spite of the calendar, of the astronomical May-day as a fair-day. At ten places in Wales fairs are held on May 6, namely, Abercennen, Laugharne, Castell Bychan, Mon., Castleton, Mon., Llanfynydd, Newcastle, Pemb., Llanfair Caereinion, Llangynog, Llanerchymedd, and Nantglyn. I have given the names of the places because of many facts connected with them which deserve further study in this connection. For instance, Ystradgynlais, Penderyn, and Devynnock occupy different slopes of the same mountain range, the Brecknock Beacons, where the May-year survives in its glory. Again, in all Wales it is probable that the traditions of May-day have not been better preserved than in the neighbourhood of Laugharne, where prehistoric monuments are numerous.

It may be said, then, that there was a three weeks' interval depending on May-day, and reckoned from that date.

Coming to the summer solstice, I note three fairs held on May 31, three weeks as reckoned from the solstice, instead of May 29. The places are Llangollen, Llanbrynmair, and Talgarth. The two-days' fair at Carmarthen, June 3, 4, leads up to June 24. The summer solstice is observed by fairs at Llandilo Fawr, Llantwit Major, Emlyn, Llanerchymedd, and Ely Bridge.

Depending on the August festival (August 8) are intervals of three weeks both before and after that date. At Llanerchymedd, fairs are held on the three Wednesdays before August 7. That takes us back to July 17. The true commencement of the preparatory interval would be July 18, and not 16, as per table given. There are fairs at Haverfordwest and Llanidloes on July 18, and one on July 19 at Caerphilly. It is interesting to note that a ten-days' fair at Warrington, Lancs, commenced on July 18. At two contiguous places, occupying different slopes of the same mountain range, the three weeks' interval is reckoned after the August festival. There are fairs held at Rhayader, Radnorshire, on August 6 and 27, and at Rhos, Cardiganshire, on August 5 and 26.

I find only one warning interval of the autumnal equinox, but it is as decisive as any. At a noted mountain fair-place, called Waen, where the boundaries of Breconshire, Monmouthshire, and Glamorganshire meet, fairs are held on September 2 and 24.

That there was a three weeks' interval depending on All Hallows is shown in the case of Llanerchymedd, where fairs are held on the three first Wednesdays after November 13, Old All Hallows. The commencement of a preparatory three weeks' interval, leading up to November 8, would be October 18, and fairs are held on that date at Haverfordwest and Myddfai. The latter place is famous for its wealth of tradition. At Llanfechell, Anglesey, fairs are held on November 5 and 25, which should be compared with the Llanerchymedd fairs in the same county.

Fairs are held on November 30, St. Andrew's Day, in Cardiff and at Llansannan, and that was the date of the commencement of a ten-days' fair at Warrington.

It is in Anglesey, where Sir Norman Lockyer observed a tendency in the monuments to ante-date the solstice, so to speak, that we find definite arrangements of fairs confirming his findings.

Information on the point, from the monuments and the fairs or festivals, is as yet incomplete. I am only trying to coordinate some of it. A court used to be held every three weeks in the parish of Llangeinor, Glam. The Roman notice of the Comitia extended over three market-days. Banns must be published on three Sundays.

Concerning the winter solstice celebrations, one is reminded of the Boy Bishop of Salisbury, a choir-boy elected as bishop on St. Nicholas' Day, December 6, who was allowed to bear the title until Holy Innocents' Day, December 28, just three weeks. The Christmas festivities used to be continued in Pembrokeshire for three weeks. The Government in the time of Charles I. prohibited the playing of cards, &c., at Gray's Inn during the year, "except on the twenty days of Christmas holidays only."

I cannot help thinking that a three weeks' interval is provided for in the orientation of some churches. As a rule, the older churches are oriented to May or November; then come churches oriented to the equinox. I find N. 76° or 77° E. and N. 80° or 81° E. to be rather common orientations.

Since writing the foregoing, I have looked up some Welsh calendar lore. Provision seems to have been made for the various three-weeks' intervals suggested by the fairs. There appear to have been four Lents, as they may be called. The source of my information is Dr. Gwenogvryn Evans's report on a Peniarth MS., which he dates "after 1484" ("Report on Welsh MSS.," vol. i., pp. 406–7). Dr. Evans gives only the beginning of each item in the MS.

There was a "pask bychan," little Easter, connected with the Feast of St. Hilary, January 13, which is just three weeks before the February festival of the May-year, February 4. January 13 is also St. Elian's Day, and at Llanelian, Anglesey, the Gwyl Mabsant, or patronal wake, used to be prolonged for three weeks.

Then there was the "pask" (Easter) proper. Mention is also made of the "pask kynharaf," the earliest Easter, though the report on the point is tantalisingly brief. As Easter proper ends the ecclesiastical year, the "earliest Easter" may very well be connected with the August festival of the May-year, August 8, as suggested by the fairs.

Then comes the "grawys ayaf," winter quadragesima. It is connected somehow with the Feast of St. Linus, and that is all I can gather from the report. St. Linus' Day is November 26. Though the word "grawys" is a shortening of "quadragesima," perhaps it is here applied to the shorter interval of Advent. It certainly corresponds with the latter. It is worth noting, however, that January 13 is some forty days from the beginning of the winter "grawys."

Thus we have three "pasks" or Easters mentioned, and the word "grawys" used twice. I suspect that there were four of each, corresponding with the four seasons of the year, and the four Gorsedds of the Bards.

JOHN GRIFFITH.

Women and the Chemical Society.

WE venture to ask for the hospitality of your columns in order to make a statement of some importance in view of the announcement made by the president of the Chemical Society of the large majority of the fellows who are in favour of the admission of women to the society (Proc. Chem. Soc., 1908).

Four years ago a memorial was presented to the council of the Chemical Society praying for the admission of women to the fellowship of the society. This memorial bore the signatures of nineteen women, all of whom were lecturers or demonstrators in chemistry in university colleges or actively engaged in original chemical investigations. The council at that time was unable to take any steps in the matter, but promised that the memorial should not be lost sight of in any further action that might be taken (Proc. Chem. Soc., 1905, xxi., 103).

The question having been raised again by the presentation of a petition signed by 312 fellows in June last, we communicated in July with our co-signatories of the 1904 memorial, and with other women of equal repute as chemists, in order to ascertain how many women at the present time desire the privileges afforded by fellowship of the Chemical Society.

We have received replies from twenty-eight women, all of whom are of similar standing and possess similar qualifications to those of the original signatories, expressing their interest in the present movement and their intention of at once becoming candidates for admission to the fellowship of the Chemical Society if the council should reach a favourable decision in this matter.

From rumours that have reached us, there appears to be some uncertainty in the minds of some fellows of the society as to the number of women who are prepared to avail themselves of the first opportunity of seeking the fellowship, and we hope that the publication of the above statement will remove all misunderstanding on this point.

IDA SMEDLEY.
M. A. WHITELEY.

November 9.

Mercury Bubbles.

I REMEMBER seeing mercury bubbles, like those described by Mr. J. G. Ernest Wright in NATURE of November 5 (p. 8), sixty years ago, when I was a junior student at the Royal College of Chemistry under Hofmann. In the basement laboratory was a tap delivering water under considerable pressure from a cistern on the roof, and it was a favourite experiment to take a basin half full of mercury and water and to turn the tap suddenly on it. The rush of water carried down air into the mercury, and great bubbles of the metal rose, floating on the surface of the water. I do not remember seeing bubbles as large as 22 mm. in diameter, but frequently they were as large as ordinary marbles.

I cannot recall any publication of the phenomenon, but there must be many chemists living who can corroborate what I have described. WILLIAM CROOKES.

November Meteors.

THAT memorable and suggestive epoch, the middle of November, has again arrived. At midnight the well-known stars in the "Sickle of Leo" exhibit themselves in the east and suggest meteors galore to the expectant observer. The conditions are not favourable this year, for the parent comet returned in 1899, and must now, with the denser region of its meteoric swarm, be at an immense distance from the earth. The probability is, therefore, that we shall only encounter a tenuous part of the stream, and that a few straggling Leonids will illumine our skies on the nights following November 14 and 15, but the meteors may be much more numerous than expected, as they have been in certain previous years.

The moon will be near her east quarter, and situated in the same region of sky as the radiant at the important time, so that her light will offer some impediment in regard to the fainter meteors.

It will be desirable to maintain a watch of the sky on the mornings of November 15 and 16, and to record, not only the number of meteors visible, but the apparent paths of the brighter ones. An important end is served by securing duplicate observations of individual objects, and thus enabling their real paths in the atmosphere to be computed. Apart from this the annual observation of a meteoric shower, whether rich or feeble, is necessary in learning its history, for even negative results concerning its return may be really valuable, though the spectacular effects are disappointing in the extreme. With particular regard to the Leonids they are never wholly absent, being

distributed along the complete ellipse forming the cometary orbit. They are therefore always worth careful notice, and will seldom be found to fall below reasonable expectation.

Bristol, November 4. W. F. DENNING.

THE result of calculations made by the writer indicates that the Leonid epoch will fall a little later this year than might have been expected. There will be little, if any, meteoric activity during the period November 10–16, reckoning from noon to noon, but during the remainder of the month it is likely that shooting stars will be much in evidence. The following are the principal meteor showers that fall during the period November 16–30, the dates of the occurrences being expressed in Greenwich astronomical time :—

Epoch November 16; this shower is of the ninth order of magnitude, and has the following maxima :—November 16, 11h. 20m.; November 17, 4h. 25m., 8h. 20m., and 16h. 15m.

Epoch November 17, 20h., of eleventh order of magnitude. The following maxima occur after the epoch :—November 18, oh. 50m., 10h. 14m.; November 19, oh. 40m., 5h. 5m., and 16h. 50m.

Epoch November 20, 5h., of fifth order of magnitude, and preceded by the following maxima :—November 18, 7h. 50m., 21h. 5m.; November 19, 5h. 55m.; November 20, 3h. 15m.

Epoch November 24, of seventh order of magnitude, which has the following maxima :—November 24, 8h. 55m., 12h. 10m.; November 25, 6h. 20m., 18h. 24m.

Epoch November 30, 5h., of fifteenth order of magnitude, and preceded by the maxima :—November 28, 14h. 30m., 20h. 30m.; November 29, oh. and 3h., 20h. 45m.

It seems from the foregoing that the first maximum takes place on November 16 during the hour preceding mjdnight. This maximum, which is the only one occurring on this night, will probably furnish some Leonids, which may also be observed on the following night.

131 Rathgar Road, Dublin. JOHN R. HENRY.

The Keeping of Young Herring Alive in Captivity.

ON p. 305 of the new number of the Journal of the Marine Biological Association reference is made to the difficulty of keeping young herring alive. On September 14 last I captured a number of young herring; some, which I put under circulation in salt water, were dead next morning. To kill the others I turned on a fresh-water tap into the bucket containing them. Half an hour or so later I found that, instead of being dead, they were very lively, and some which had been lying on their backs had recovered.

I then placed seven under a circulation of half salt water and half fresh water. They lived for a week, then some of them died off. There is still (November 6) one lively specimen living, and apparently healthy. The only source of food is a little plankton added (twice), and such plankton as comes through the salt-water pipes.

During the first few days of this experiment sometimes the salt-water tap and at other times the fresh-water tap was shut off for an hour or so.

RICHARD ELMHIRST.

Marine Biological Station, Millport, N.B.

Lime Light.

I VENTURE to direct your attention to a simple device which I have found very useful for increasing the light from a demonstrating lantern. It is usual, on account of their long life, to use so-called artificial lime cylinders, even though they give somewhat less light than pure lime ones. An ordinary Welsbach gas-mantle happens to fit all these cylinders, and should be slipped on before the jet is lighted. The increase in brightness of the light due to this addition is astonishing. The mantle is only slightly damaged by the jet, and by turning occasionally so that the flame impinges upon a fresh place, the intense illumination may be maintained for two hours or so.

Shooters Hill, Kent. CHARLES E. S. PHILLIPS.

ALBRECHT VON HALLER.

ALBRECHT VON HALLER, anatomist, physiologist, botanist, and poet, was born in Berne on October 16, 1708. He has been termed "Berne's greatest son," and his intellectual eminence was conspicuous even in an age which was singularly productive of great men. It was, indeed, early manifest, for the child Haller was what the Germans term a "Wunderkind"—one of the few such children whose subsequent career has borne out the promise of their youth. As early as his ninth year he began the preparation of lexicons of all the Hebrew and Greek words in the Old and New Testaments, with notes regarding their derivations and different applications. He also prepared a Chaldaic grammar. Whilst still a boy he wrote biographies of no fewer than two thousand celebrities and turned out innumerable verses (which he afterwards burned) on all conceivable subjects, including a satire in Latin verse on his somewhat harsh and pedantic preceptor. Before he was fifteen he was deeply immersed in philosophy and mathematics, and already showed that inclination towards the natural sciences which eventually evidenced itself in the remarkable works which appeared from his pen.

At fifteen he entered the University of Tübingen and pursued the study of anatomy and philosophy during two years. At this time Boenhaave, a man of similar almost universal genius, then at the zenith of his fame, was attracting to Leyden earnest students from all parts of the civilised world. The youthful Haller was also drawn into the vortex, and came under the influence both of that great physician and of the anatomists Ruysch and Albinus. After graduating there at the age of nineteen, Haller visited England, and in London made the acquaintance, amongst others, of Sir Hans Sloane, Douglas, Cheselden, and John Hunter. He then proceeded to Paris, where he spent six months studying anatomy and botany under Winslow and Jussieu. After leaving Paris, he passed a year in Bâle, pursuing mathematical studies under Bernouilli, and preparing himself for the active practice of medicine in his native city, where he intended to settle down. At the age of twenty-two we accordingly find him in practice in Berne. His patients do not appear to have been numerous; indeed, it was currently reported that he was "too good a writer and poet to understand much of medicine," and he found abundance of time for working at anatomy and for expeditions to the neighbouring Alps, the flora of which especially excited his interest. The poem entitled "Die Alpen," which was composed by Haller about this time, is probably the one by which he is best known; the following two verses from it, set to music as a cantata by Dr. Munzinger, were sung at the unveiling of the Haller statue on October 16 :—

Wohl dir, vergnügtes Volk! o danke dem Geschicke,
Das dir der Laster Quell, den Ueberfluss, versagt;
Dem, den sein Stand vergnügt, dient Armut selbst zum Glücke,
Da Pracht und Ueppigkeit der Länder Stütze nagt.

Zwar die Natur bedeckt dein hartes Land mit Steinen,
Allein dein Pflug geht durch, und deine Saat errint;
Sie warf die Alpen auf, dich von der Welt zu zäunen,
Weil sich die Menschen selbst die grössten Plagen sind.

In 1735 Haller had begun to lecture in public on anatomy, and was physician to the city hospital in Berne. We also find him fulfilling the function of keeper of the public library and collection of coins. In the short year occupied with these multifarious duties he found time to prepare a "catalogue raisonné" of all the books in the library, and to differentiate and arrange in their chronological order 5000 ancient coins. In the following year George II.

of England, who was establishing a university at Göttingen, induced Haller to accept the chair of medicine, surgery, anatomy, and botany. He there gave himself up entirely to professorial duties and to work in natural science. He was instrumental in founding, in 1737, the Royal Society of Sciences in Göttingen, of which he became secretary and president, and the first meetings of which were held in his house. After seventeen years in Göttingen he accepted the invitation of his fellow-citizens to return to Berne, where already, in his absence, he had been elected a member of the Supreme Council, and he now (1753) devoted himself to administrative duties with the same energy that he had put into literary and scientific studies. These studies were not, however, arrested, for every moment of his time unoccupied by public affairs continued to be filled in by them, and his activity in this respect ended only with his death in 1777. He even sent a detailed account of his last illness to the Royal Society of Göttingen, and is said to have remarked to his physician at the approach of death that his pulse was no longer perceptible:—"Es schlägt nicht mehr!"

Haller is justly celebrated as a botanist, and had he not been a contemporary of Linnæus, whose great reputation eclipsed that of all his fellow-workers, he might have attained as high a position in that science as he reached in anatomy and physiology. He prepared a complete flora of Switzerland, and propounded a system of classification—artificial, it is true (as was that of Linnæus), but one which might have served a useful purpose in the absence of the Linnæan system. He published several important botanical works, the chief being the "Historia stirpium indigenarum Helvetiæ," which appeared in 1768 in three folio volumes with one volume of plates; the "Bibliotheca botanica," 1771–2, in two quarto volumes; the "Histoire des Plantes vénéneuses de la Suisse," 1776, and several descriptive monographs.

As an anatomist Haller was still more eminent. Already in 1733 he published at Berne a "Dissertatio anatomica de musculis diaphragmatis," followed in 1738, at Göttingen, by another, "De Valvula Eustachii." In 1743 he began the publication of his great work, the "Icones anatomicæ," which appeared in eight successive folio parts, the last in 1756. This was the first anatomical work in which the organs of the body are shown as much as possible in relation to one another, a principle which has been followed by all subsequent authors. As accessory to his anatomical writings may be mentioned his contributions to development and pathology.

But it is as a physiologist that Haller unquestionably ranks highest—indeed, modern physiology may be said to date from the appearance of his great work, "Elementa physiologiæ corporis humani," which came out from 1757–1766 in eight quarto volumes.[1] Into this book he collected all the physiological knowledge of his time, and the clearness with which he narrates the facts of physiology and the logical manner in which he draws deductions from them may serve as a model for modern text-books. His manner of pursuing a theme and clinching his conclusions is shown even by the mere titles of his chapters. Thus, in the section of the book in which he deals with the history of the discovery of the circulation and the attempts which had been made to detract from the claims of Harvey to the merit of the discovery, these titles read in succession as follows:—

XXIV. "Harveio laus circuitus inventi vindicatur." XXV. "Non exstat apud Hippocratem." XXVI. "Neque apud Salomonem, Platonem, veteres alios." XXVII. "Neque apud Servetum, Jacobum Reeff (longe minus)." XXVIII. "Quid Cæsalpinus viderit (non penitus tamen verum vidit, Harveio reservatum)." XXIX. "Non est inventum Pauli Sarpi." XXX. "Neque aliorum nuperorum." XXXI. "Neque Sinensium aut Persarum." XXXII. "Sed Harvei." For every statement the authority is given. Wherever possible, an observation is confirmed by himself. The descriptions of physiological phenomena are concise and clear. The deductions are not always those which we are now in the habit of drawing, but the exceptions are singularly rare.

It was only the dawning of chemistry, and many branches of physics were unknown; physiology, therefore, in those days had to be based mainly upon the study of anatomy. "Physiologiæ est animata anatome," says Haller in his "Primæ lineæ physiologiæ in usum prælectionum academicorum," a little handbook for medical students, published at Göttingen in 1748, which went through eleven editions. In the same work (p. 41) he recognises the value of animal experiments in advancing the knowledge of human physiology:—"Accuratiora sunt quæ in vivis animalibus facta sunt experimenta," and he is even more emphatic on this point in the introduction to his "Elementa."

Albrecht von Haller.

When it is stated that Haller published nearly 200 works, it must be admitted that few or none have possessed a more fertile literary ability, especially when the scope of many of these works is taken into consideration. For, besides the great tomes on botany, physiology, and anatomy already mentioned,

[1] "The year 1757 may be regarded . . . as indicating the dividing line between modern physiology and all that went before. It was the year in which the 'Elementa Physiologiæ' of Haller was published." Michael Foster, "History of Physiology," p. 204.

he prepared and published no fewer than four large biographical works, one on botany, one on anatomy, one on surgery, one on practical medicine—the first of these in two quarto volumes, and the last occupying as many as four. These "Bibliothecæ" contain not only lists of scientific works, but also short analyses and criticisms of their contents, along with biographical notices of the authors—a titanic labour of vast utility to subsequent workers. Nor were his writings confined to the natural sciences. As we have already seen, he early attained considerable fame as a poet; later we find him publishing historical novels —"Usong, an Oriental Story," 1771; "Alfred, King of the Anglo-Saxons," 1773; "Fabricius and Cato, a Fragment of Roman History," 1774. His "Journal," which was published ten years after his death, contains his opinions on other literary men and on things in general, and especially philosophy and religion. Both this and his correspondence manifest strong conservative and anti-democratic views, with a tendency to intolerance towards those who held different opinions.

Haller was loaded with honours during his lifetime. He was an honorary member of almost all the learned societies of Europe. Frederick the Great in vain attempted to induce him to settle in Berlin, and the endeavours of Oxford and Utrecht to obtain his services were equally futile. The King of England appointed him his physician, and the Emperor of Germany granted him a title of nobility. But he was himself content to live and die a simple citizen of Berne, a prophet not without honour in his own country.

Haller's bicentenary was celebrated at Berne with great ceremony in October by the inauguration of a statue erected in front of the university on a height overlooking the town. On the day preceding the inauguration a joint session of the Historical, Medico-chirurgical, and Scientific Societies of Berne was held in the hall of the university, which was occupied by a large audience, including many ladies. Interesting accounts of Haller's life and work were given by Prof. Steck (history), Prof. Fischer (botany), and Prof. Kronecker (physiology). Addresses were also received from various societies with which Haller had been connected, as well as from universities and other learned bodies. The societies were represented by Prof. Leo, who appeared for the Royal Society of Sciences in Göttingen; Prof. Waldeyer, for that of Berlin; Prof. Heger, Brussels; Prof. Bohr, Copenhagen; Prof. Rückert, Munich; Prof. Wangerin, Halle; Prof. Gamgee, London (presenting a Latin address from the Royal Society); Prof. Schäfer, Edinburgh; whilst the universities were represented by Prof. von Grützner, of Tübingen; Prof. Merkel, of Göttingen; Prof. Kollmann, of Bâle; Prof. Ewald, of Strassburg, and others. In the evening a reception was held in honour of the foreign delegates by the president of the memorial committee, Prof. Tschirch.

The actual day of the inauguration (October 16) was kept as a public holiday. A procession of all those who were to take part in the ceremonial, including the Swiss and foreign delegates, the university authorities, and the students—the latter with the banners and in the uniforms of their respective corps —was marshalled in front of the Parliament buildings, and marched through the principal streets of the old city to the site of the memorial. There, orations were pronounced by the rector of the university, Prof. Tschirch, and by State Councillor Dr. Gobat, representing the Education Department of the Canton. A fine choir of men's voices rendered a selection of appropriate music, and in glorious sunshine, to the accompaniment of the booming of cannon and the sound of the Swiss national anthem, the covering which had concealed the monument was removed, and the representation of Haller, by Siegwart, of Lucerne, was displayed to the view of the assembled multitude.

The statue represents Haller as he might have appeared to his contemporaries in about his fiftieth year. No contemporary picture or bust of this period of his life is extant, although his appearance in earlier and in later life is not unfamiliar. The sculptor had, therefore, to imagine him at the period chosen—which was that of his greatest scientific activity—a circumstance which has certainly not detracted from the artistic merit of the statue.

The unveiling ceremony was followed by a banquet to the delegates and others who had been invited to the celebration. Not the least interesting of the guests were some of the direct descendants of Haller. Indeed, the reply of M. Albert de Haller, of Lausanne, to the toast of the Haller family showed that some at least of the literary ability of his ancestor has descended to his generation.

The festivities were wound up by a torchlight procession of students, followed by a "Kommers" in the Kornhaus-keller.

A bronze plaque, exhibiting the bust of Haller in profile, designed by the sculptor of the memorial, was struck to commemorate the bicentenary, and a copy was presented to each of the foreign delegates—an artistic memento of a memorable ceremony.

E. A. S.

CAISSON DISEASE.[1]

MEN who have been working in compressed air, either under water in diving dresses or diving bells, in caissons used in preparing foundations for bridges, &c., or in making shafts or tunnels through watery ground, are liable to a variety of symptoms known generally as "caisson disease." These symptoms, which come on only at or shortly after the return to atmospheric pressure, vary in severity from pains in the muscles and joints, known as "bends" or "screws," to paralysis and even death. Paul Bert showed experimentally thirty years ago that these attacks are due to the fact that air (chiefly nitrogen) which has been dissolved in the fluids and tissues of the body while under pressure may, on decompression, be liberated in the form of bubbles, which produce local or general blocking of the circulation or other injuries. He also showed that if decompression were effected sufficiently slowly, the excess of air which had been taken up could escape by diffusion through the lungs, and thus bubbling and symptoms could be avoided. The phenomenon is, in fact, that of decompressing soda-water by pushing in the stopper; the problem of the prevention of caisson disease is how to push it in so slowly that the gas can escape without forming bubbles, and without the loss of so much time that the primary object of the manœuvre is frustrated.

Practical experience has shown clearly that the incidence of caisson disease varies with the height of the pressure and the duration of exposure to that pressure. Cases of illness are much more frequent in caissons where the pressure required to keep out the water approximates to 45 lb., or 3 atmospheres in excess of atmospheric pressure, than in those which are worked at about 20 lb. or 25 lb. Yet far higher pressures may be experienced with impunity

[1] "The Prevention of Compressed-air Illness." By A. E. Boycott, G. C. C. Damant, and J. S. Haldane (*Journal of Hygiene*, vol. viii., 1908, p. 342).

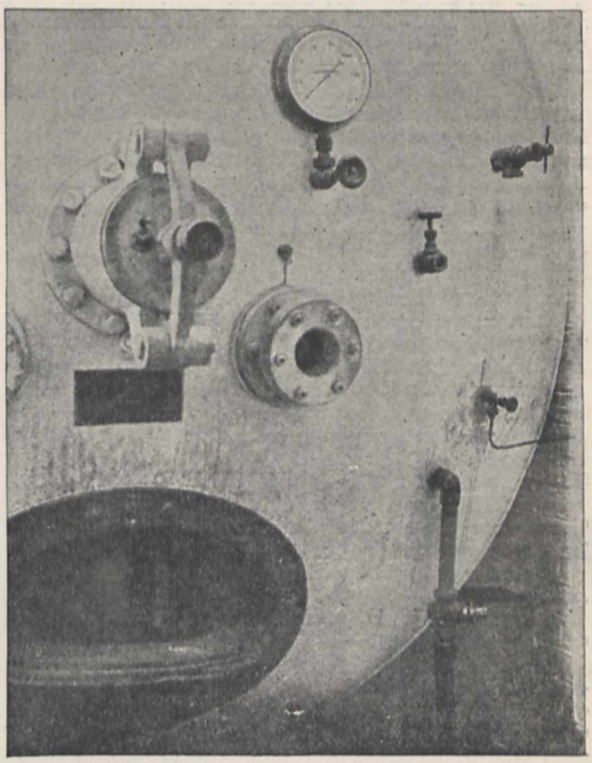
if appropriate precautions be taken. Dr. Greenwood has exposed himself to as high a pressure as 92 lb. in an experimental pressure chamber, and Lieut. Damant and Gunner Catto have descended in diving dresses to a depth of 210 ft., or 94 lb. In these cases the time of exposure to compressed air was very short, and human experience in caisson work definitely shows that it is more dangerous to work for six hours than three, and that exposures of half an hour or so are usually quite free from risk. Practical experience is, however, by no means so clear with regard to the salutary effect of prolonging the period of decompression. The cause of this is that the really slow decompressions which are necessary have hardly ever been tried in actual practice, with the result that many practical men are still somewhat sceptical as to the truth of Paul Bert's discovery.

The formation of gas bubbles in the living body obviously depends on the pressure of the gas dissolved in the body being greater than the external pressure. It is, however, well known that liquids, and especially sticky liquids such as blood, can hold gas in a state of supersaturation at pressures much in excess of the external pressure without the formation of bubbles, especially if they are not agitated or brought into contact with foreign substances. These phenomena are well illustrated by soda-water after decompression, noting the effects of shaking the bottle or adding sugar to the lemon-squash. If the limit of "safe" supersaturation is exceeded, bubbles are formed. Whether this occurs or not in the body will depend, then, on the extent to which the body has become saturated while under pressure, and the point to which the saturation has been reduced during decompression. How much gas is taken up while under pressure and given off during decompression depends in the main on the height of the pressure, the duration of exposure, the duration of decompression, and the activity of the circulation of the blood, which is the means whereby the air is brought from the lungs to the tissues, and subsequently evacuated from the tissues *viâ* the lungs.

The different parts of the body vary very widely in respect of the quantity of blood passing through them in unit time. Those that are freely supplied with blood, such as the kidneys, take up excess gas very quickly, and in such parts the nitrogen pressure soon comes into approximate equilibrium with the nitrogen pressure in the air in the lungs. By some ingenious experiments Drs. Hill and Greenwood have shown that this point is reached in as little as ten minutes in the case of the active human kidney. Practical experience shows, however, that other parts of the body take much longer—four or five hours or more—to become saturated with nitrogen at the given excess air pressure, and, further, that the importance of these slowly saturating parts as regards caisson disease is much greater than that of organs which saturate quickly, and which, therefore, desaturate correspondingly fast on returning to atmospheric pressure.

The duration of the exposure to high pressure is, then, of the utmost importance; it should in all cases be reduced to the shortest practicable time. The duration of decompression must, on the other hand, be much extended if accidents are to be avoided. It is also clear that the rate of decompression should be adjusted to the height of the pressure and the duration of exposure; what is safe after one hour at 60 lb. pressure would be waste of time if the pressure had been 30 lb. or the time of exposure only ten minutes.

Human experience shows that symptoms practically never occur after decompression from a pressure of 15 lb. in excess of atmospheric pressure, however long the exposure or however short the period of decompression. In other words, it is safe to reduce the pressure quickly from 30 lb. absolute to 15 lb. absolute. Experiments made at the Lister Institute with the aid of the pressure-chamber presented by Dr. Ludwig Mond showed that the principle that the *absolute* pressure may always be safely halved held good up to at least 6 atmospheres. A goat, for example, may be quickly decompressed from 75 lb. (90 lb. absolute) to 30 lb. (45 lb. absolute) without ill effects, while a similar rapid drop of 45 lb. from 60 lb. absolute to 15 lb. absolute is frequently followed by severe symptoms. Under a pressure difference of 45 lb., nitrogen rapidly leaves the tissues, is carried away by the blood, and diffuses through the lungs without forming bubbles. After a time,



The steel chamber at the Lister Institute. Front end, showing the manhole for entering, the small air-lock for passing food, &c., into the chamber, an inspection window, a pressure gauge, and several valves, &c. (From the *Journal of Hygiene*.)

which may be approximately ascertained by calculation, the pressure in the body will have fallen from 75 lb. to, *e.g.*, 61 lb.; the absolute pressure may again be halved, making the air pressure 23 lb. The difference of pressure inside and outside the body is now only 38 lb., so that nitrogen leaves the body more slowly than before. Ultimately the pressure difference, which must never be much more than the absolute air pressure, becomes so small that the excess gas escapes very slowly. Consequently, the rate of decompression must be made slower and slower as the pressure falls, the final decompression from 15 lb. to atmospheric pressure occupying perhaps as much as 60 minutes.

It has hitherto been customary to recommend that decompression should be effected at a uniform rate throughout, such as 20 minutes for each atmosphere of excess pressure. Such a procedure is altogether unsound; the rate suggested is needlessly slow for

the early part of decompression, and much too fast towards the end. To decompress safely a man after a long exposure at, *e.g.*, 75 lb. pressure would probably require eight or ten hours if the pressure were reduced at a uniform rate throughout; by the new method here described not much more than three or four hours would be required. At such pressures it is clear that in practice the time of exposure must be reduced.

THE DIET OF THE HINDU.[1]

CHITTENDEN'S well-known work on diet advocates a reduction of the nitrogen intake to an amount far below that in the standard Voit dietary. By experiments on others and himself, he endeavoured to show that a low protein diet is compatible with bodily equilibrium and health. He directs attention to the well-known fact that the muscular energy of the body makes little or no call on the nitrogenous constituents of the muscles, and urges that the excretory channels, such as the kidneys, are overworked and so liable to damage when dealing with the large amount of waste nitrogen which it is the habit of the white races to ingest.

The conditions which Chittenden artificially constructed for the subjects of his experiments are found ready made on a large scale in the teeming millions of Bengal. It is quite obvious that much more correct conclusions as to the ultimate outcome of a reduction of the protein intake to less than half the European standard can be drawn from such a huge experiment, extending over the lives of a population, than it is possible to deduce from a limited series of observations on a few men lasting only for a few months. Scientific investigators therefore owe a debt of gratitude to Prof. McCay for the brilliant piece of work in which he has systematically and statistically grappled with the problem.

He admits it is perfectly true that the Bengali of varying castes maintains nitrogenous equilibrium on his poor vegetarian diet, and he naturally does not dispute the dictum that nitrogen is not the source of muscular energy. But his conclusion is that the low nitrogen intake acts deleteriously; the amount of protein in the blood is permanently decreased in amount, and the poor pabulum provided for the muscles leads to work in disadvantageous circumstances, and tends to produce degenerative changes in the body cells, notably in the kidneys. Not only is the output of work by the Hindu miserably small in comparison with the European labourer, but he is more easily fatigued, his blood-pressure is below the normal, and his lack of reserve force renders him an easy prey to bacterial infection and other forms of disease. His body weight and measurements show the native to be a puny person, exhibiting all those signs usually associated with an under-fed condition.

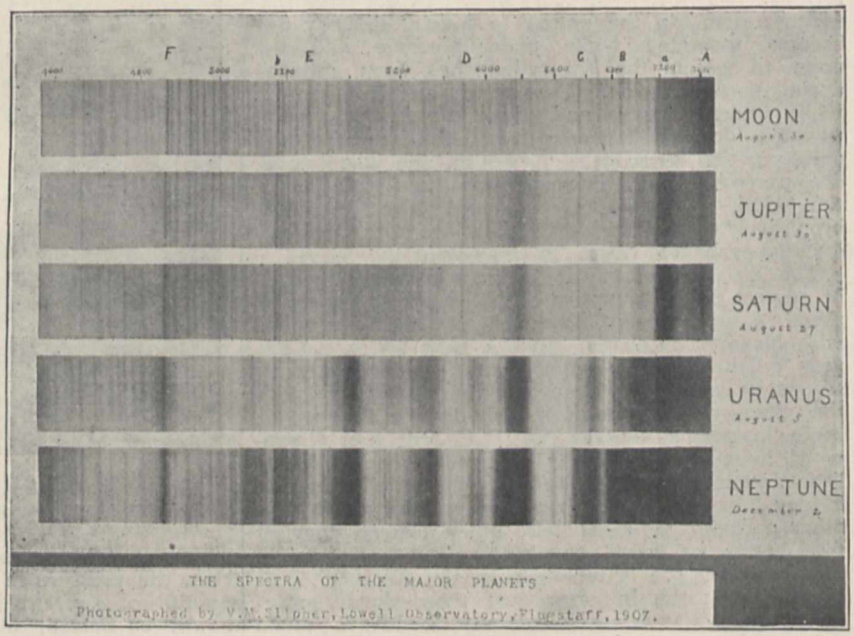
Even if one grants that in the normal decomposition of proteins, toxic substances are formed which may act injuriously upon the body, it must be remembered that in health the body is provided with an efficient machinery for eliminating them. It is by no means certain that decomposition products, also toxic in nature, are not formed from the fat and carbohydrate of the diet. The large carbohydrate intake rendered necessary by a diet poor in nitrogen seems to be full of danger, and the extreme prevalence of diabetes in its most aggravated forms among the Bengalis proves conclusively that the evils due to excess of carbohydrate are even more real than those supposed to be due to excess of protein.

The favourite argument of the vegetarian is to point to the races of the east as examples of the good results accomplished on a low diet. Such an argument has been refuted more than once, and its fallacies have been finally demonstrated by Prof. McCay's observations and statistics. W. D. H.

[1] Scientific Memoirs by the Officers of the Medical and Sanitary Departments of the Government of India (No. 34). Standards of the Constituents of the Urine and Blood and the bearing of the Metabolism of Bengalis on the Problems of Nutrition. By Capt. D. McCay. Pp. iv+67. (Calcutta: Superintendent Government Printing, India, 1908.) Price 1*s.* 2*d.*

THE SPECTRA OF THE MAJOR PLANETS.

AS the result of his experiments, Mr. V. M. Slipher succeeded in 1907 in rendering some plates (Seed, 23) sensitive far into the red. This was done by bathing them before exposure in a solution of pinacyanol, pinaverdol, dicyanin, alcohol, and water. With them he photographed the spectra of all the major planets and, for comparison purposes, that of our moon.



The results are shown in the accompanying print, made by enlarging, combining, and re-photographing on one plate all the spectra. Three things are to be observed in the spectra :—

(1) The great number of new lines and bands disclosed. Some of these are evident in the spectra of Jupiter and Saturn, but chiefly in those of Uranus and Neptune.

(2) A steady progression in the intensities of the non-solar lines and bands as one goes outward from the sun.

(3) The intensification of the hydrogen lines F and C, notably in Uranus and Neptune.

PERCIVAL LOWELL.

NOTES.

THE list of honours conferred upon the occasion of the King's birthday includes the names of three Fellows of the Royal Society. The Order of Merit has been conferred upon Dr. A. Russel Wallace, F.R.S.; Prof. J. J. Thomson, F.R.S., has been knighted; and Dr. J. Hutchinson, F.R.S., has received a like honour. Other recipients whose names are known in the scientific world are Principal Macalister, Glasgow University, who has been appointed a Knight Commander of the Order of the Bath (K.C.B.); Sir G. Anderson Critchett, who has been made a baronet; Dr. T. Oliver and Dr. N. Bodington, Vice-Chancellor of the University of Leeds, both of whom have received the honour of knighthood.

WITH deep regret we have to announce that Prof. W. E. Ayrton, F.R.S., died on Sunday morning at sixty-one years of age.

IT was announced at the West Ham Town Council on Monday that the freedom of West Ham had been privately conferred upon Lord Lister at his house in the country, as he was prevented by a weak state of health from receiving the distinction in public. Lord Lister was born at Upton, Essex, in the borough of West Ham.

WE are asked to announce that on November 28, at 2 p.m. promptly, Mr. Abbott H. Thayer, the discoverer of the concealing effect of the counter shading of the costumes of animals, will give at the Zoological Gardens, Regent's Park, a further demonstration of the obliterative effect of the patterns of so-called "conspicuous" species, illustrated with actual bird-skins, butterflies, &c., as well as with artificial apparatus and drawings. Visitors are requested to assemble in front of the superintendent's office.

MM. EDMOND PERRIER and Van Tieghem are to represent the Paris Academy of Sciences at the Darwin centenary in Cambridge next June.

THE death is announced, at the age of sixty-five, of Prof. Alfred Ditte, professor of chemistry in the University of Paris, and member of the Paris Academy of Sciences.

A REUTER telegram from Ottawa announces the death of Dr. James Fletcher, Dominion entomologist, and honorary secretary of the Royal Society of Canada.

SIR DANIEL MORRIS, K.C.M.G., has been elected an honorary life Fellow of the Royal Horticultural Society in recognition, among other matters, of his services to our Colonial Empire, and especially to the West Indies.

THE death is announced of Dr. Cecil G. Dolmage, a Fellow of the Royal Astronomical Society and many other learned societies at home and abroad, and author of "Astronomy of To-day" and other works.

MR. W. K. DAVEY has given the sum of 1000*l.* towards the initial expenses of the Australian Institute of Tropical Diseases shortly to be established at Townsville, North Queensland.

THE American Association will hold a special Darwin celebration meeting on January 1, 1909, when a number of papers upon subjects bearing upon evolution will be presented by leading naturalists. It is intended to issue the papers in a memorial volume.

WE notice with regret the announcement of the death of Mr. Archibald J. Little, who did much geographical work in the interior of Asia. Mr. Little was known as the author of "Mount Omi and Beyond," "Through the Yangtse Gorges," and "The Far East." He explored the confines of Tibet both from the Chinese and Himalayan sides.

THE Astronomical and Astrophysical Society of America will hold its next meeting, in the summer of 1909, probably at the Yerkes Observatory. Acording to *Science*, the exact date has not yet been fixed, but it is expected to precede by a few days the Winnipeg meeting of the British Association, which will open on August 25, 1909.

A CONFERENCE of fruit-growers will be held at the South-Eastern Agricultural College, Wye, on Friday, November 27. The chair will be taken by Mr. C. W. Radcliffe Cooke, and among the subjects to be discussed are insecticides, by Mr. S. Pickering, F.R.S., and spraying and spraying machinery, by Mr. E. S. Salmon.

PLANS for a new Norwegian Polar expedition were described by Captain Amundsen at a large meeting of the Geographical Society held at Christiania on November 10, and attended by the King of Norway. From the *Times* we learn that Captain Amundsen's plan is to go with Dr. Nansen's old ship the *Fram* to Cape Barrow, the northernmost point of Alaska, and thence north. The ship will drift with the ice across the Polar ocean. The *Fram* will carry provisions for seven years, but the voyage is expected to last five.

ON November 6 an inaugural meeting of the new Aëroplane Club was held in London, when it was decided to form a club devoted to the development of aërial navigation by machines heavier than air. A small provisional committee was appointed to submit to the club the names of gentlemen for service on a general committee.

THE Paris correspondent of the *Times* reports that M. Barthou, the French Minister of Public Works, announced in the Senate on November 5 that the sum of 4000*l.* is to be devoted by his department to the encouragement of aërial locomotion. From the same source we learn that the International Sporting Club of Monaco has offered the sum of 4000*l.* to be competed for at an international aëronautical meeting to be held at Monaco from January 24 to March 24, 1909. The length of the course will be about six miles. The first prize will be 3000*l.*, the second 600*l.*, and the third 40*l.*

IT is with regret that we announce the death of Dr. John M. Thome, the indefatigable director of the Cordova Observatory, who since the retirement of Dr. Gould conducted the work of that institution with marked ability and success. By his loss science is deprived of an ardent and able observer, one who was willing to forsake the more attractive departments of astronomical research and to labour at the very necessary drudgery connected with the compilation of a southern Durchmusterung and similar work, necessitating the wearying and continual repetition of the same process. In some directions sufficient recognition has not been made of the assiduous efforts of Dr. Thome to carry on the work of the observatory with the efficiency and with the magnificent output that characterised Dr. Gould's enterprising direction, and unfortunately in this place we have not room to do justice to his twenty-three years' administration. A very limited acquaintance with the volumes issued from the Argentine Observatory must convince anyone, not only of the value and amount of observation that has been accomplished, but of the difficulties against which Dr. Thome continually struggled. A possibility of war has more than once been made the excuse by the Minister of Public

Instruction for reducing the staff, and we can well sympathise with the director in his endeavour to maintain the activity and honourable record of the institution with a diminishing staff consequent upon a vanishing budget. Trustworthy services by competent assistants could not be secured, and the energies of the director had to be devoted to examining and correcting the operations of those who were both inefficient and negligent. We may record, however, his own statement made in 1904, which shows that under his administration there had been produced four volumes giving the places of 630,000 stars with their magnitudes, resulting from more than 1,800,000 observations, together with eighteen charts containing 550,000 stars. These figures are quite sufficient to demonstrate his industry, but if we remember that in addition to this work Dr. Thome cheerfully gave aid in the matter of photographing a zone of the Astrographic Chart, it will be admitted that an amount of work stands to his credit which entitles him to rank among the earnest and devoted supporters of astronomical science.

ANOTHER astronomer who has passed away after rendering long and efficient services is Mr. Andrew Graham, whose name was familiar to two generations of scientific workers, for nearly seventy years have elapsed since he began his astronomical career at Colonel Cooper's observatory at Markree, in Ireland. It was Mr. Graham's fortune to take part in two movements, which have had unexpected developments—the discovery of asteroids and the construction of a Durchmusterung. Before the number of small planets had reached double figures he added Metis to the list, and he lived to see the number grow inconveniently large. The zones of ecliptic stars observed at Markree were among the early efforts of a mode of observing which has since been extended to the whole heavens, to the great advantage of astronomy and the convenience of observers. It was fitting that he who had laboured at the pioneer work of determining approximate positions should end his career by sharing in the magnificent task of giving accurate places to the stars contained in Argelander's survey. For nearly forty years Mr. Graham worked at the Cambridge Observatory under Prof. Adams, during which time he devoted himself with unwearying zeal mainly to the observation of the zone allotted to the Cambridge Observatory in the scheme inaugurated by the Astronomische Gesellschaft. At the advanced age of ninety-three this industrious astronomer has departed, mourned by many friends in the University of Cambridge, where his long services were gratefully acknowledged, and where his memory will long be treasured.

WE have to acknowledge the receipt from the authors, Messrs. Gibbs and Barraud, of a copy of a paper, from the Transactions of the Hertfordshire Natural History Society, on the two-winged flies of that county.

TO Captain S. S. Flower we are indebted for a copy of a list of the zoological gardens of the world, drawn up by himself, and published in Egypt. The number of such gardens is eighty.

AN association has been established in connection with the Norwich Museum, of which the first report is now before us. Its object is to arrange demonstrations illustrative of economic natural history and horticulture. A considerable number of such exhibits was displayed during last year, and apparently aroused a fair amount of public interest.

FOR the last few years the council of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne has had to record a decrease in the membership roll of that body. In the report for the past year it is satisfactory to see that a slight increase is recorded in this respect, although a considerable addition is required in order to put the society on a satisfactory footing. The list of additions to the museum is comparatively large.

A FINELY illustrated account, by Mr. F. Heatherley, of a visit to the ternery at Wells-by-the-Sea forms the opening article in the October number of the *Zoologist*. Two species are found nesting on this site, namely, the common and the lesser tern; they have separate colonies of their own, probably for the reason that they would disagree if mixed. The author adds that the common tern, when on the wing, may be distinguished from the Arctic tern by its much less jerky flight and its habit of hovering, in kestrel-fashion, when fishing. It is also reported to carry its tail closed more frequently than is the case with the Arctic species.

WE have received copies of the second parts of the *Sitzungsberichte* and of the *Verhandlungen* for 1907, issued by the Naturhistorischen Vereins der preussischen Rheinlande und Westfalens. The former contains a large number of short articles, mainly devoted to local zoology, botany, palæontology, and geology, and to refer to any of these separately would appear invidious. The *Verhandlungen* comprise five longer papers, also mainly on local subjects, Mr. R. Schaufs discussing the copepods and cladocerans of the Bonn district, Mr. K. Röttgen the coleopterous fauna of the Rhine province, Mr. W. Bruhns volcanic bombs from Schweppenhausen, and Mr. A. Hasebrink the Cretaceous formation of the Teutoburg Forest.

THE various methods of developing and preparing fossils for exhibition or for the purpose of study are discussed at considerable length by Dr. F. A. Bather in a paper read before the Ipswich Museums' Conference, and published in the September issue of the *Museums Journal*. In cases of hard and intractable matrix something may in certain instances be accomplished by purely physical methods, such as heating limestones and then plunging them into cold water, by splitting ironstone nodules with the aid of a freezing mixture, or by saturating the rock, when sufficiently porous, with a quickly crystallising solution like magnesium sulphate, when the act of crystallisation loosens the particles of the superficial layer. In other instances, however, it is necessary to resort to chemical agents of various kinds.

TO the September number of the *American Naturalist* Prof. T. D. A. Cockerell contributes a paper on some of the results of the expedition sent from Colorado to collect the Tertiary fossils of Florissant. In addition to the large number of species of insects, one of the most interesting fossil types obtained is *Trichophanes foliarum*, an aberrant fish of the perch group originally described from Nevada. In Florissant these fish apparently lived in open water during the great glaciation, entirely cut off from the southern fauna; they were accompanied by another waning type—a species of bowfin (Amia). As regards the flora, the great problem to be determined is whether certain leaves indicate representatives of the Proteaceæ, a group now confined practically to the southern hemisphere. As in the case of the European fossils which have been assigned to the same group, no one, according to the

author, can say definitely that these remains are not proteaceous. If they be referable to that group, we have, in Prof. Cockerell's opinion, further evidence of a land-connection between the great southern continents. In our own view this is not so, as the supposed Proteaceæ might apparently have travelled from north to south along the main continental lines.

IN describing the skull of a domesticated dog from a prehistoric station of the Hallstatt period, near Karlstein, Amtsgericht Reichenhall, Dr. T. Studer (*Mitt. naturfor. Ges. Bern.*, 1907, p. 155) takes the opportunity of reviewing the state of our knowledge of prehistoric dogs generally. In the Palæolithic epoch we have *Canis poutjatini*, an animal of the size of a German sheepdog, with all the general characters of *C. familiaris*, but showing affinity with the dingo of Australia and *C. tenggerianus* of Java. This dog probably lived with Palæolithic man in a half-wild condition, and by crossing with the wolf seems to have given rise to a breed like the "laiki" of Siberia, this being represented by *C. inostranzewi* of Lake Ladoga and the Phalbauten of Lake Neuenburg, while by a cross with a flat-headed wolf arose the Neolithic *C. leineri*, the ancestral form of the modern deerhounds. In another line we have from *C. poutjatini* the sheepdogs, and in yet another the hound group, the earliest representatives of which are *C. matris-optimae* and *C. intermedius* of the Bronze age. Perhaps by further crossing with the wolf or with *C. inostranzewi* was produced the small *C. familiaris palustris* of the Pfahbauten. Crossing of the larger breeds, aided perhaps by intermixture with high-skulled wolves, gave rise to the boarhound group, to which the Karlstein skull pertains, this group not making its appearance until the Glacial period. The group seems to have been characteristic of the Alpine region, where it is still represented by the St. Bernard.

THE whole of the conjoint issue of Nos. 1–3 of the *Bulletin de la Société Impériale des Naturalistes de Moscou* for 1907, comprising 430 pages and six plates (which has just been issued), is devoted to a paper by Prof. A. N. Sewertzoff, of St. Vladimir University, Kiew, on the development of the muscles, nerves, and limbs of the lower four-limbed vertebrates, with special reference to a theory relating to the pentadactylate extremities of vertebrates in general. The author claims to be the first to have investigated the subject from the point of view of the muscles and nerves, previous workers having confined their attention to the skeleton. It is considered that in the ancestral Tetrapoda (Protetrapoda) the skeleton of the free extremities was composed of a small number of skeletal rays, probably not exceeding seven, such a type of extremity being evidently derived from a sparsely rayed fin. On the pre-axial side the number of rays (four) must have been greater than on the post-axial (two). Each ray was segmented, and consisted of a large number of similarly formed short elements, such elements being most numerous in the main axis and least so in the peripheral rays. The main axis of the protetrapodous fin formed a right angle with the spinal axis. In many respects the fore-fin of Ceratodus approximates to this ancestral type, but it must be assumed that the Tetrapoda are derived from a form in which the fins had a horizontal direction. Such a direction probably existed in the ancestors of Ceratodus, whence it may be inferred that the extremities of the Pentadactylia and the Dipnoi have had a divergent evolution. Accordingly, it seems probable that the pentadactylate extremity has been evolved from a "dipnopterygium" which was specialised towards the Ceratodus type. The resemblance to the latter may, indeed, be partly due to convergence, but the author is nevertheless convinced that Dipnoi and Tetrapoda have been evolved from the same stock.

AN article by Dr. A. J. Ewart, published in the Proceedings of the Royal Society of Victoria (vol. xxi., part i.), deals with the longevity of seeds, and touches on several interesting side-points. The summary of a long list of germination tests shows that a large number of leguminous seeds are macrobiotic, that is, they maintain their vitality for a long period; outside this family comparatively few seeds, and those chiefly belonging to the mallow and myrtle orders, could be so described. A marked feature of most macrobiotic seeds is an impermeable coat, shown by Miss J. White to be supplied by the cuticle. The best method of inducing germination in the case of hard-coated seeds consists in steeping the seeds in sulphuric acid for a few hours.

THAT the breeding of plants with the object of tracing the results of specific raisings or crosses requires very elaborate precautions will be patent to anyone who has contemplated such work. Dr. G. H. Shull contributes an article to the *Plant World* (vol. xi.) on pedigree culture, in which he describes the precautions taken at the Station for Experimental Evolution. The soil for the cultures is sterilised in autoclaves, surface watering of the seed-pans is avoided so far as possible, and paraffin bags are used for covering up the flowers. No less important than the cultural details are the labelling of specimens and the registration of records, on which subjects the author offers some suggestions.

THE part (No. 8) of the *Kew Bulletin* recently issued is assigned to two extensive systematic articles on the Gentianaceæ; the former, contributed by Dr. A. W. Hill, deals with the genera Sebæa and Exochænium; the latter, by the director, Lieut.-Colonel Prain, traces the limits of the genera Chironia and Orphium. A note records the identification of two new rubber-yielding plants from Madagascar as *Plectaneia elastica* and *Mascarenhasia lisianthiflora*, both apocynaceous genera, but neither species appears to have much economic value.

A VOLUME of the *Memoires du Comité géologique de Russie* (part xxxviii.) is devoted to the description of certain Jurassic plants from the Caucasus and Turkestan, prepared by Prof. A. C. Seward. The collections from the Caucasus include impressions of Equisetites, also fertile and sterile fronds of *Klukia exilis*, *Marathiopsis Muensteri*, and a new species of Zamites. Among the Turkestan specimens, well-preserved casts provide the material for a new species, *Equisetites ferganensis*; the others are chiefly fronds of ferns such as Cladophlebis and Coniopteris, but some fragments are referred to Ginkgo and coniferous genera.

WE have received a fine *opus* registered as vol. xxv., article 19, of the Journal of the College of Science, Tokio University, in which Mr. B. Hayata describes certain flowers collected on Mt. Morrison and other slopes of the Formosan range. Some of the collections are not yet worked out. The determinations furnish indication of careful compilation, the printing is generous, and the plates form an admirable contrast to many inferior process illustrations now too often provided. The conifers supply the most notable group, as they include a Libocedrus, two new species of Juniperus, a new and only

the second species of Cunninghamia, and the genus Taiwania, fully described elsewhere. The list contains several species, some new, under the genera Quercus, Gentiana, Rhododendron, Hydrangea, and Clematis. The discovery of a species of the American genus Oreopanax is extraordinary. The general affinities lie with the flora of southern and central China, and even more closely with the flora of Japan.

THE report on rainfall registration in Mysore for 1907 has been sent to us by Mr. N. V. Iyengar, chief observer in charge. The average rainfall over the whole of the province during 1907 was 6·6 per cent. in excess of the mean for the last thirty-eight years; this result was chiefly due to excessive rainfall in the Shimoga and Kadur districts. The actual rainfall of the year 1907 and the average for 1870–1907 are exhibited cartographically, and the whole work gives evidence of careful preparation.

WE have received the Bulletins of the Philippine Weather Bureau for September and October, 1907, prepared under the direction of the Rev. Father Algué. In addition to daily and monthly means, earthquake reports, and agricultural notes for a number of stations in the archipelago, they contain much useful information relating to the meteorology of a large portion of the North Pacific, for the net-work of the service includes stations far to the east, in the W. Caroline and Ladrone Islands. These outlying stations make it possible to announce the existence of typhoons in the Pacific long before their influence is felt to any extent in the Philippines, and to send useful warnings to other organisations in the Far East. Tracks of four such cyclonic storms which occurred in September are plotted, all of which re-curved at great distances from the Philippines. The disastrous typhoon which visited Hong Kong on the morning of September 18, 1906, without having given on the previous evening indication of its approach, has led the watchful observers at Manila to add an electrical alarm attachment to their mercurial barograph. This invention is fully described, with illustrations, in the October bulletin. At the close of the day the attachment is so adjusted that "the forecaster may retire for the night with the assurance that he will be warned faithfully in case the barometer should take a sudden plunge downward."

IN NATURE of July 16 we reviewed the report of the Japanese Earthquake Investigation Committee on the secondary oscillations of oceanic tides. The last number of the *Bollettino della Società Sismologica Italiana* (vol. xii., No. 11) contains a memoir on the same subject, by Dr. E. Oddone, whose researches had been carried out independently, and communicated to the society before the publication of the Japanese report. Dr. Oddone recognises the fact that these secondary oscillations, as well as the seiches of lakes, can only exist when they synchronise with the natural period of vibration of the water contained in the bay or lake, but points out that if this were the only controlling factor, and the phenomenon merely one of resonance and the selection of vibrations, we should find seiches and secondary tidal oscillations of every period. He asserts that this is not the case in nature, and that on tabulating all the periods which have been observed they are found grouped in the neighbourhood of a period of sixty-six minutes or of its harmonics; as sixty-six minutes is the calculated period of elastic vibration of the earth as a whole, and the periods most frequently observed in the secondary tidal undulations and seiches agree with those which, in another memoir, Dr. Oddone had indicated as seismic constants, he comes to the conclusion that the exciting cause of both seiches and of the secondary undulations of the tides is to be found in the deformation of the earth as a whole, which, acted on by some internal or external force, tends to take on an elastic vibration of a constant period uninfluenced by the nature of the exciting cause. These vibrations are communicated to bodies of water, and reinforced when the natural period of oscillation of one or more sections of the basin corresponds to generating rhythm or one of its harmonics. Whether this conclusion is accepted or no, the paper is a suggestive one and useful, if only for its summary of the published researches and observations on the subject with which it deals.

THE most important contribution to the second issue of the Bulletins and Memoirs of the Société d'Anthropologie of Paris for the current year is an elaborate paper by Dr. Rivet, in which he sums up the results of the discussions on the remains of primitive man discovered in 1843 in a cave near Lagoa Santa, Minas-Géräes province, in the upper San Francisco basin of Brazil. In all eighteen skulls, the majority of which are in the Copenhagen Museum, are available for examination. Unhappily the age of the remains discovered by Lund cannot be clearly fixed; but from the associated fauna they may be assigned to the Pliocene or post-Pliocene period. In general, the skull form is dolichocephalic. Dr. Rivet enters upon an elaborate comparison of these specimens with those of the allied Paltacalo group. He attempts to show, with some measure of success, that these remains represent the primitive inhabitants of Southern and Central America, these having been dispersed by an intruding race into the outlying districts in Brazil, Patagonia, Chili, and California, where their physique was to some extent modified by their later environment. There is, perhaps, no part of the world where our information regarding primitive man is more deficient than in the region covered by this contribution; and it can hardly be said that the skulls available for examination are sufficient to support far-reaching speculations. It may be hoped that further craniometrical evidence will soon become available to supplement the material which the writer has collected with such devoted labour.

THE Government Museum and Connemara Library at Madras, under the management of Mr. E. Thurston, continues to make satisfactory progress. One of the most interesting features of the museum is the extensive ethnographical collections which have been made by the curator in the course of his annual tours. Southern India is particularly rich in examples of demon-worship, sorcery, and magic. Among recent acquisitions is a remarkable example of sympathetic magic in the shape of a wooden representation of a human being which was washed ashore on the coast near Calicut. The figure is made of soft wood, and is eleven inches in height. The arms are bent on the chest, and the palms of the hands are placed together, as in the act of saluting. A square cavity, closed by a wooden lid, has been cut out of the middle of the abdomen, and contains tobacco, narcotic hemp, and hair. An iron bar has been driven through the body, and terminates in the abdominal cavity. A sharp cutting instrument has been driven into the chest and back in twelve places. A similar figure, life-size, was washed up on the same coast some years ago, and is figured in Mr. Thurston's "Ethnographic Notes in Southern India" (plate xix.). These figures seem to be peculiar to the Laccadive Islands, the people of which are notorious sorcerers. They apparently represent persons possessed by an evil spirit, which is

symbolically nailed to the figure, with certain offerings of propitiation, before the latter is flung into the sea, in order to free the islands from its presence. The theory that spirits can be shut up in jars or figures is familiar in the tale of the Jinnee in the "Arabian Nights," and is accepted by savages and semi-savages in many parts of the world.

OWING to the enormous reduction in the price of aluminium which has recently taken place, it seems quite likely that this metal will be largely employed instead of copper in many instances, for example, as a conductor, and it is also probable that it will be used in place of tin. At one time it was a difficult matter to roll out very fine sheets of aluminium, but further experience has enabled the manufacturers to roll sheets even finer than that of the ordinary tin foil. Aluminium rolled out in this manner will probably in the near future replace tin foil for a great many purposes, for example, the covering of chocolates and food-stuffs, also for wrapping up materials for keeping out damp. Tin is, at the present, about double the price of aluminium, and it has, furthermore, to be borne in mind that the specific weight is about one-eighth that of tin, consequently, weight for weight, it is possible to roll out eight times the number of sheets from aluminium to what could be obtained from tin. Tin salts are more or less poisonous, whereas aluminium salts, at any rate in small quantities, are practically harmless, so that children eating sweetmeats from which they have not taken the trouble to remove the tin foil might do themselves considerable harm, but if aluminium were substituted for tin the chances of doing themselves ill would be far less.

THE relatively high electrical resistivities of alloys as compared with the resistivities of their constituents has been attributed in succession by Lorenz, Ostwald, Rayleigh, and Liebenow to the thermoelectric effects produced by the passage of the current through minute layers of the constituents of the alloy arranged in series with each other. Herr E. L. Lederer, of the University of Prague, has determined the resistances of wires of a number of alloys by the bridge method and by measuring the heat developed in the wires by means of a calorimeter. His results are given in the February number of the *Sitzungsberichte* of the Academy of Science of Vienna, and the resistances determined by the two methods appear to agree to within less than 1 per cent. Herr Lederer concludes that the thermoelectric theory of resistivity of alloys is therefore untenable.

IN our account of the "Mathematics and Physics at the British Association," Prof. Lamb is credited with saying (NATURE, November 5, p. 24):—"The daily variation of temperature is not harmonic, and when it is analysed there is a definite component with a half-day period. The objection to attributing the semi-diurnal pressure variation to this is that the latter is extremely regular, while the temperature variation changes considerably with the locality." Prof. Lamb writes to us to explain that this contains a passage which conveys a rather different meaning from what he (at any rate) intended to say. He does not think there is any valid objection to attributing the semi-diurnal pressure variation to the semi-diurnal component of temperature vibration on the above-stated ground. "A forced oscillation whose amplitude is exaggerated owing to the near coincidence of its period with a free period has necessarily all the simplicity and regularity of the corresponding free mode." We are glad to have the opportunity of correcting our report in accordance with this communication.

ALTHOUGH the study of the refractive indices of gases may be expected to lead to theoretical conclusions of great importance, no very definite conclusions have been drawn until recently from the existing experimental data. This is partly due to the delicacy of the physical measurements involved, but chiefly owing to the difficulty of obtaining the gases in a pure state. The first regularity in the refractivities of a series of chemical gaseous elements was pointed out by Mr. C. Cuthbertson in connection with the argon group, and in the current number of *Science Progress* he gives a clear and interesting *résumé* of the present state of knowledge as regards gaseous refractive indices. The refractivities of the five gases helium, neon, argon, krypton, and xenon are found to be almost exactly in the ratios of 1, 2, 8, 12, and 20, and Mr. Cuthbertson has detected a similar set of ratios in other chemical groups, notably in the halogen and oxygen groups. There can be no doubt that the discovery of the cause of this simple numerical relation will throw light on the structure of the atoms. As is pointed out in the article, there is still room for much experimental work, some of it of a high order of difficulty, before the true meaning of these remarkable relations can be elucidated.

MESSRS. GEORGE ROUTLEDGE AND SONS, LTD., have published a second edition of "The Case for the Goat, with the Practical Experience of Twenty-five Experts," edited by "Home Counties." This edition includes some new data on goat-keeping and new illustrations, while the opportunity has been taken to make various emendations.

WE have received from Messrs. E. and F. N. Spon a copy of the second edition of Mr. C. J. Woodward's "A B C Five-figure Logarithms for General Use." In this edition an index has been given on the inside pages of the cover to find the page on which a given logarithm of an arc function will be found, and a table of natural arc functions to each minute of arc to four places of decimals has been added. The price of the volume is 3*s*. net.

THE fourth part of the first volume of Proceedings of the Association of Economic Biologists, that for September, 1908, is now available. It is chiefly devoted to the papers read at the meeting of the association held in London on April 15 of this year, and reported in our issue of April 23. The number also contains a summary of a meeting held on July 4, and the annual report.

A SERIES of excellently produced catalogues has been received from Messrs. Ross, Ltd., of New Bond Street and Cockspur Street, London. Catalogue No. 1 deals with photographic lenses; field, studio, and hand cameras; lanterns, and the numerous miscellaneous accessories required by the photographer. The price of this catalogue is one shilling. A second booklet is entitled "Aids to Vision for Naval and Military Officers, Sportsmen, Naturalists, &c.," and is devoted to descriptions, with prices, of such instruments as prism binoculars, field glasses, telescopes, sextants, magnetic compasses, barographs, and barometers. The remaining pamphlet, called the "Ross Bird-stalker," is a report by Mr. Charles Dixon on the advantages, possibilities, and uses of the Ross prism binocular, as applied to field natural history. All the catalogues include, in addition to the more usual illustrations of instruments, numerous beautiful process pictures of objects and scenes reproduced from photographs.

OUR ASTRONOMICAL COLUMN.

COMET MOREHOUSE, 1908c.—Numerous results of observations, appearing in several journals, indicate that in comet 1908c we have one of the most interesting cometary visitors that has been discovered of late years.

In the *Comptes rendus* for October 26 (p. 730, No. 17) M. Borrelly describes the observations made at the Marseilles Observatory between September 12 and October 3, and states that his photographs bear evidence of striking changes in the form and extent of the tail system. On September 20 two branches of the tail were shown, one rectilinear, the other curved, and the general appearance resembled that of Donati's 1858 comet; on September 28 the double tail was 5° in length, but on October 2, although triple, it was much shorter. Five tails were shown on the plate of October 3, and the trail of an occulted star indicates a slight absorption effect.

According to M. L. Rabourdin, observing at Meudon, great changes took place from one day to the next, and obvious changes were observed even during the course of an hour; on several plates the tail has an undulating appearance.

Changes, similar to those recorded above, are described by M. Gautier in No. 4278 of the *Astronomische Nachrichten* (p. 97, October 29). The observations were made at the Geneva Observatory during the period October 14–18.

According to a letter to Mr. H. C. Plummer, which appears in the *Observatory* (No. 402, p. 423, November), Prof. Barnard followed the comet closely from September 2 to October 13, and got one or more photographs on each of thirty nights during that period. He states that the photographs of September 30 are unique, whilst the transformation, which took place between the taking of them and the taking of his next one on October 1, was very wonderful. Fortunately there is a Greenwich photograph taken during the interval.

We give below a further extract from Prof. Kobold's ephemeris:—

Ephemeris 12h. M.T. Berlin.

1908	α (true) h. m. s	δ (true) ° ′	1908	α (true) h. m. s	δ (true) ° ′
Nov. 12	18 52·5	+8 46·3	Nov. 22	18 50·8	−0 21·2
14	18 52·0	+6 45·0	24	18 50·7	−1 55·0
16	18 51·6	+4 50·0	26	18 50·5	−3 24·7
18	18 51·3	+3 0·8	28	18 50·4	−4 50·3
20	18 51·0	+1 17·3	30	18 50·4	−6 12·6

DONATI'S COMET AND THE COMET OF 69 B.C.—Following up the suggestion that Donati's comet (1858 VI.), of which the period is probably something like 2000 years, was identical with the great comet recorded in the Chinese annals as having appeared in 69 B.C., Herr Kritzinger has compared the available data, and finds that the elements differ so much, especially in the inclination of the orbit plane, that the identity cannot be maintained. In fact, the Chinese comet cannot be identified with any later bright comet. Of all the earlier comets, it appears that the one recorded in China in 146 B.C. is the most likely to correspond with Donati's, but the identity is, at the best, very uncertain (*Astronomische Nachrichten*, No. 4277, p. 65, October 20).

TERRESTRIAL ELECTRICITY AND SOLAR ACTIVITY.—In No. 15 of the *Comptes rendus* Dr. A. Nodon reports that on October 2 his instruments at the Bordeaux Observatory indicated a violent change in the terrestrial electrical charge, and states that this change coincided with the passage of an area of solar activity. He further directs attention to the fact that the changes preceded a violent cyclone, which devastated Guadeloupe, and a magnetic storm, which was registered strongly at the Parc Saint-Maur Observatory.

THE "ASTRONOMISCHEN GESELLSCHAFT" AT VIENNA.—The twenty-second general meeting of the "Astronomischen Gesellschaft" was held at Vienna on September 15–18, and a report of the proceedings, contributed by Prof. Kobold, appears in No. 4277 of the *Astronomische Nachrichten* (p. 71). A proposal to hold the 1910 meeting either in America or at Breslau was discussed, the assembly deciding in favour of the latter.

NEW CATALOGUES OF PROPER MOTIONS.—In No. 4276 of the *Astronomische Nachrichten* (p. 49, October 9) Dr. Ristenpart publishes a second list giving the proper motions, in R.A. and dec., of some 150 stars. The usual designation, the position for 1900, the magnitude, and the precession correction for each object are also given.

The first fascicule of vol. iv. of the "Annales de l'Observatoire astronomique de Tokyo" is also devoted to a catalogue of proper motions. In it Mr. K. Hirayama gives the declinations and proper motions of 246 stars employed in the Tokyo latitude observations, and discusses at length the processes by which they have been determined; the present discussion only includes stars not given in the *Jahrbuch*. In the first table the designation and the particulars of each star as they appear in the various catalogues employed are given, whilst the second table includes the resulting declinations and proper motions.

THE INTERNATIONAL CONGRESS ON TUBERCULOSIS AT WASHINGTON.

EVEN in these days of crowded congresses the International Congress on Tuberculosis, held in the last week of September and the first week of October in Washington, must stand out as a most remarkable meeting, especially in point of numbers, and were it not that the work there attempted was largely "educational" in character, and that the arguments and appeals for better methods of combating tuberculosis were directed to a much wider circle than that gathered in Washington, the promoters might well feel that they had undertaken a task for which the return could not be commensurate with the energy they had to expend. There can be no doubt that the congress was far too large to allow of careful and dispassionate discussion of many of the points that were raised in the different sections, but equally there can be no doubt that the moral and educational effect of such a meeting as that held at Washington must be enormous, not only in the United States and Canada, but in every part of the civilised world.

The keynote of the whole meeting was enthusiasm and earnestness combined with thoroughness. Following the lead offered by the British Association in the meetings in South Africa, the congress was divided into a series of peripatetic bands, which, as they made their way to Philadelphia, Washington, and New York, gave addresses and demonstrations on the special topics on which they were authorities. When the congress was over there were innumerable demands (most of which could not be met owing to the fact that the meetings were held so late, and that most of the delegates hastened home to their respective work as quickly as possible) for lecturers to tarry and give addresses in the various eastern towns of the States and Canada. As soon as a number of the French and English delegates arrived in Quebec, Montreal, and Toronto, they were first feasted, and then asked to address municipal bodies, chambers of commerce, boards of trade, and the like, and Dr. R. W. Philip caught the public ear at once by his terse and lucid statement of the Calmette-Philip dispensary system, which has been attended with such marked success in reducing the death-rate from tuberculosis in Edinburgh. At Montreal the way was thus prepared for a great autumn anti-tuberculosis campaign and exhibition, organised by Prof. Adami and his colleagues. Invitations were received from Chicago, Detroit and elsewhere, but the time before the congress was so limited that many of these had to be refused. Exceedingly convenient was the arrangement to hold a meeting of the International Association for the Prevention of Tuberculosis at Philadelphia a week before the actual discussions were to come on in Washington, and great credit must be given to the president, Dr. Lawrence Flick, to Prof. Pannwitz, the secretary, and to the organising committee in Berlin for the excellent programme there presented to the members.

Of course, much time and energy were devoted to the presentation and discussion of reports on sanatoria, on isolation, disinfection, immunisation against, and treatment of, tuberculosis, and it was interesting to note what

efforts are being made by sanitary authorities all over the civilised world to combat this disease. It was realised, as never before, how widespread and serious are the results of tuberculosis, and at the same time how keenly alive, not only the medical profession, but health authorities generally, have become to the importance of dealing even in drastic fashion with the "white scourge." At the end of each day a popular lecture on some aspect of the question was given, these lectures being entrusted to Dr. Pannwitz, on tuberculosis in its social aspects; Dr. Theodore Williams, on the history of the treatment of tuberculosis; and Dr. Calmette, on the tuberculin ophthalmic reaction, with which his name is now so intimately associated. This preliminary conference had a special interest from the fact that it was authoritatively stated that Koch had been somewhat misunderstood at the London congress, and that his position as regards the non-transmissibility of bovine tuberculosis to the human subject was not so directly opposed to what may be called the popular view as had been held to be the case. Needless to say, such an expression of opinion was received with almost a sigh of relief by those who are convinced of the possibility of such communicability. So strongly was the congress impressed with the necessity of ensuring a milk supply free from any possible contamination by tubercle bacilli that on the last day Prof. Heymans, of Ghent, moved, and it was passed with acclamation, that a committee to inquire into the conditions under which milk may become so contaminated be appointed, and that it report at the conference to be held in Brussels in 1910. This committee is thoroughly international, and representative of both the medical and veterinary professions.

During the Philadelphia week large numbers of those specially interested travelled to Washington to inspect the excellent museum that had been brought together by an energetic organising committee under Dr. H. J. Beyer. No such complete, interesting, and instructive exhibition had ever been brought together before, partly because no such material had hitherto been available. It is open to question whether medals and prizes constitute a desirable means of stimulating exhibitors, but in this instance, although we hope that this distribution of prizes will not form a regular feature of these exhibitions, our American cousins may claim that the success that has attended their efforts justifies the means employed. In the matter of prizes, especially money prizes, Great Britain comes out well; Brompton Hospital, represented by Dr. Theodore Williams, Dr. Lathom, and Dr. M. S. Patterson, takes a prize of one thousand dollars offered for the best exhibit of a hospital for the treatment of advanced cases of pulmonary tuberculosis, whilst the one thousand dollar prize offered for the best exhibit of an existing sanatorium for the treatment of tuberculosis amongst the working classes was divided between the Brompton Hospital Sanatorium at Frimley and the Whitehaven Sanatorium at Whitehaven, Pa.

Another prize, part of which came to our side of the Atlantic, was that offered for the best evidence of effective work in the prevention of tuberculosis since the last congress held in Paris three years ago, the Women's National Health Association of Ireland and the committee on tuberculosis of the New York Sanitary Organisation Society dividing both the honours and the money. Other prizes were the first gold medal, awarded to Great Britain, for the best pathological exhibit, and a silver medal to Dr. Sims Woodhead and Mr. William Henman for plans, with elaborate details and descriptions, of a sanatorium. These are given as examples of the range of subjects for which prizes were awarded; but others were an exhibit of the best laws and ordinances in force on June 1, 1908, for the prevention of phthisis, for which the State of Wisconsin was awarded a gold medal, New York City taking a similar award for the best set of laws and ordinances for the prevention of phthisis shown by any municipality in the world, whilst the awards gained by the National Swedish Anti-Tuberculosis Association further illustrate the eclectic character of the exhibits. This association gained two gold medals, one for having the largest number of any organisation in the world which is fighting phthisis, and a second for exhibiting the best plans for raising money with which to wage the crusade against tuberculosis. Again, Dr. D. Sarason, of Berlin, received a gold medal for models and plans showing new and interesting principles in house construction in its relation to the prevention of tuberculosis. These are simply examples of a large number, but they serve to indicate the lines on which the organising committee got together a good museum—by making a definite demand, a demand which in most cases was promptly met from many quarters. Certain of the visitors before seeing the exhibitions scarcely seemed to realise that many of the schemes and plans described in connection with the various American municipalities were anything more than paper plans, but the working plans, models, and statistics soon made it clear that a large amount of very valuable work has been done and effective measures taken to stem the tide of tuberculosis.

Although a great deal of educational work was done in the pathological, clinical, social, surgical, municipal, veterinary, and other sections, there can be little doubt that the centre of interest was the discussion in the combined sections of bacteriology and tuberculosis of animals, at which Prof. Koch maintained that the practical aspect of the question was so important that he felt justified in confining his attention to it. He was satisfied that the tubercle bacilli in bovine tuberculosis were different from those in human tuberculosis, and that although human beings may be infected by the bovine tubercle bacilli, serious disease rarely occurs as a result of such infection. The human bacilli, on the other hand, play a far more important *rôle* in the spread of tuberculosis. He did not claim that the results announced at London were final. He and Dr. Schultz then asked that their experiments should be repeated. Many experiments had been carried on, but he should still like to ask how far sources of error had been eliminated. Animals must be free from spontaneous tuberculosis, the early stages of which cannot be recognised.

Tuberculin, of course, had to be used in connection with this work. Further, it was evident that experiments on too small a series of animals could carry but little weight. Then all animals must be protected from any external infection, especially that of bovine origin, and it was, of course, essential that different series of experiments should be kept absolutely separate. All the infections should be made by subcutaneous injection with early cultures that had not passed through more than a single guinea-pig. He believed that doses of ten milligrams were most satisfactory, and he was satisfied that it was a mistake to use too large doses or to introduce the virus by intravenous or intraperitoneal injection. Of course, there should be no contamination of the cultures. He and his colleague had found that all bacilli from bovine source, when injected into cattle, gave rise to progressive, and ultimately generalised, lesions, but that tubercle bacilli of human origin gave rise to localised and regressive lesions only. He wished to point out, too, that as experiments must necessarily extend over long periods, it was essential during this time to eliminate the possibility of secondary infection. Finally, they had to remember that mixed infection by the human and bovine bacilli might occur.

In regard to the experiments of the British commission, he pointed out that immense quantities of phthisical sputum had been given to calves and pigs, and that it was possible that this sputum had contained milk or butter in which were bovine tubercle bacilli.

The first case to which he referred was placed amongst the positive results. To be of value, he considered that the sputum should have been taken from one case only, and that all possibility of infection by either milk or butter should have been eliminated. He thought the British Royal Commission failed in several respects, and that many of his opponents had not been sufficiently careful on certain of these matters. He maintained that he had never held that we were dealing with two distinct species, but that we had to deal with two different types.

Bearing this in mind, he considered that laboratory experiments, bearing on modification of the characters of

the bacilli, were merely of academic importance, and that any question arising out of them was merely of theoretical value. We had to deal with the properties of "fresh" bacilli, and with these only. He believed that competent investigators were in agreement that the human tubercle bacillus differs from the bovine tubercle bacillus, that this latter does not cause progressive tuberculosis in man, and that, therefore, from the practical point of view, it might be left out of consideration in our crusade against tuberculosis.

Prof. Theobald Smith, though agreeing with certain of Dr. Koch's contentions, was by no means in accord with him as to the sharp line of demarcation that he drew between the human and bovine types of the tubercle bacillus. He believed, moreover, that there was an actual increase of virulence obtained by passage, and that a selective and protective action of the tissues probably comes into play, and he was convinced that increased virulence did not mean change of type.

Prof. Sims Woodhead claimed that in no sense of the word did the members of the British Royal Commission regard themselves as Koch's opponents. He believed they were all working to one end—the elucidation of a problem which Prof. Koch had set before them, a problem he was satisfied they were all anxious to solve, in great measure, too, because of the respect in which they held their great colleague, though even his great authority could not outweigh their own observations and conclusions. In regard to the conditions laid down by Koch, the British Royal Commission had exercised the greatest care to observe each one. Their Government had been induced to spend a very large sum in order to provide sufficient help, and through the patriotic generosity of Lord Blyth a couple of farms, a considerable distance from each other, which could be completely isolated, and a central laboratory between the two, to which material to be worked out could be brought, thus doing away with any necessity for any direct communication between the farms, had been placed at their disposal. As to animals, they were fortunate in having near them an island in which tuberculosis had never yet broken out among the cattle—Jersey—and from which they had been able to obtain a very large supply of bovines on which to carry out their very numerous experiments. They had obtained the assistance of well trained and enthusiastic experts in whom they had every confidence, and the results they had obtained had been set forth in their reports in the greatest detail, so that those who questioned their opinion might see the data on which they were founded, and he asked anyone who read their report to go to the appendix to the report for the details of any case in which they thought there might be any doubt; they might then form their own opinions.

He asked them to accept all this as evidence that they, the commissioners, and their Government were at one with Prof. Koch in looking upon the question as an intensely practical one. They felt that no stone should be left unturned to test the accuracy of statements of such enormous importance, and from the experimental evidence they had been able to obtain they were of opinion that conclusions had been arrived at on quite insufficient data. Prof. Koch had criticised a single one of their experiments. They had taken the utmost care to eliminate the dangers that Prof. Koch had pointed out; but, allowing for a moment that there were flaws in this experiment, one of the earliest that they conducted, he would direct attention to other cases, bearing on the same point, in which he believed they would find no such opening for criticism. It could not be a question of merely "academic" interest when some 30 per cent. of the cases under five years of age reported by the two commissions, the British and the German, were of alimentary origin, for, as calculated by Dr. Cabbett, this meant that about 7 per cent. of the cases of tuberculosis probably resulted from infection from a bovine source, and 7 per cent. of the cases, allowing a little latitude on either side, could not be looked upon as a negligible quantity. Prof. Koch had stated that the alimentary cases were selected, but he should like to point out that at first this was done for a short time because Prof. Koch had been able to find so few cases in Germany. Later they found this unnecessary.

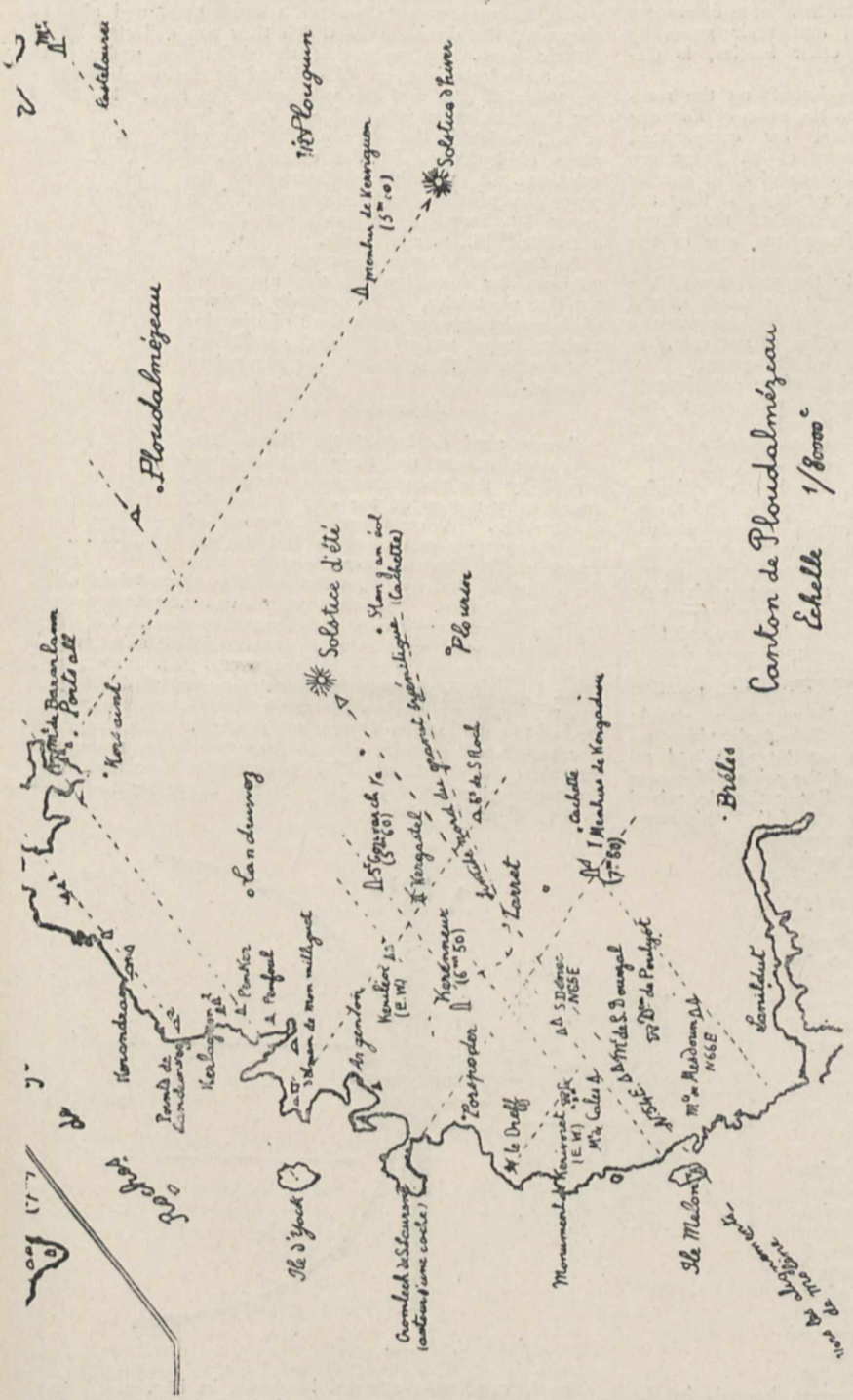
In regard to the question of modification of tubercle bacilli, he was not in a position to say more than had appeared in the report of the commissioners, but he would like to point out that the period after the infection at which the disease manifested itself was so great that many people could not bring themselves to believe that cause and effect were in any way associated, and they scoffed at the idea of tuberculosis being infective. Would not this slow growth place similar difficulties in tracing the modification either of morphological characters or of virulence of the tubercle bacilli? Was it not possible, however, that some of the conditions that regulated the modification of the more rapidly growing bacilli should obtain in the more slowly growing bacilli, allowing, of course, for the much longer period necessary for these modifications to come into effect?

He thought that those who undertook the responsibility of saying that there is no danger to the community, either directly or through an increase of tuberculosis amongst cattle, accepted a very grave responsibility indeed, and for his part he was so impressed by the evidence that had already been obtained, not only in England, America, and Germany, but in France, Denmark, and elsewhere, that he should be loath to countenance the relaxation of a single regulation having for its object the extermination of bovine tuberculosis. Indeed, he would go further, and say that in the interests of the public health still more stringent regulations might have to be put into force.

The outcome of the various discussions may be summed up in the statement that there can be no tuberculosis without the tubercle bacillus, and that although under certain conditions the human subject and the lower animals may resist the invasion of this micro-organism, there are times and conditions in which the vitality and resisting power of the tissues are so greatly impaired that the tubercle bacillus is able to invade the body and cause degenerative lesions in the tissues, and tuberculosis is set up. It was agreed that no hard and fast rule can be laid down for every set of conditions under which the tubercle bacillus is or may be present, but that every means should be taken to kill the bacillus as it comes from any centre of infection before it has had time or opportunity to infect other organisms, and that at the same time all possible means should be taken to raise the insusceptibility or resisting power of any organisms that may be attacked. In open and advanced cases of tuberculosis isolation of the human being and slaughter of cattle are advisable. In the case of cattle an affection of the milk gland should be a sign for the destruction of the animal affected. The sanatorium treatment should be looked upon as being useful from three points of view:—(1) as isolating the patient temporarily; (2) as giving opportunity of instructing the patient as to the best means of disinfecting sputa, &c., which, under ordinary conditions, are a great source of infection; and (3) as commencing the treatment and building up of the patient and educating him as to what, in the interests of his own health, he may do and what he may not. In this connection it may be pointed out that Dr. M. S. Patterson's demonstration of the excellent work that is being done at Frimley was one of the most valuable and instructive lessons given at the congress. He showed that graduated labour seems to help to immunise the patient, to build up his physical powers, to give him confidence, and to improve his morale in so far that, instead of allowing him to degenerate into a valetudinarian, with thoughts only of his own ailments, he receives the inspiration of the knowledge that he can still work and earn his own living, and not only this, but that under proper conditions work is a factor in his recovery. At the present time, when we have promises of legislation in the air, one cannot but feel that those who are responsible for legislation concerning tuberculosis cannot do better than study carefully the results that have been obtained abroad by men perhaps with less experience than ourselves, but also less hide-bound by precedent and tradition than are we. The announcement of the intention of the Local Government Board to enforce compulsory notification of phthisis amongst poor-law patients, for which Dr. Newsholme said he had the authority of the President of the Local Government Board, was received with loud applause at the opening meeting of the congress.

CAPTAIN DEVOIR'S ARCHÆOLOGICAL RESEARCHES IN BRITTANY.

SOME months ago Sir Norman Lockyer directed attention in NATURE (vol. lxxvii., p. 56) to several interesting cases of inter-relation among the stone monuments of Britain. Captain Devoir, a distinguished officer of the French Navy and an accomplished surveyor, has sent us some plans he has recently prepared of a similar inter-relation he has found in Brittany, and among them one in the Canton of Ploudalmézeau. The plan, which he has permitted us to reproduce, shows how all the alignments there are directed to the solstices, or the May-year sun, and that they are continuous over a large stretch of country.



Captain Devoir's map of some of the Brittany alignments.

ANTS AND THEIR GUESTS.

IN a series of papers recently published in the *Biologisches Centralblatt*,[1] Father Wasmann gives us the result of recent elaborate observations and experiments respecting the behaviour of different species of ants living together in the same nest towards each other, and likewise their treatment of the small beetles and other parasites which are in the habit of taking up their abode in ants' nests.

The position of these beetles is very peculiar. By some species of ants they are encouraged and by others they are destroyed, and what is still more remarkable is that some of the beetles which are encouraged and tended by the ants themselves actually feed on the eggs or larvæ of their hosts. The beetles of the genus Atemeles are killed in nests of *Formica rufa* and *F. pratensis*, but they are tolerated in mixed colonies of *F. pratensis* and *F. fusca*, and of *F. rufa* and *F. fusca*. However, as soon as a queen of *F. rufa* was introduced into one of these nests, the Atemeles, which had previously been unmolested, were discarded and massacred. The larvæ of a beetle referred by Wasmann to the genus Lomechusa is extremely destructive to the ant-brood, and although it seems to be tolerated in the nests of *F. sanguinea*, yet its eggs and larvæ seem to be sooner or later devoured by ants of other species if they happen to be found there, and though the perfect beetles do not seem to be molested, they generally die after a few days in nests of other species of ants.

Similar observations on beetles belonging to the genus Dinarda, and on various other ant-guests, including spiders, we will pass over, but the small isopod *Platyarthrus hoffmannseggi* deserves notice. Ants are usually so indifferent to its presence that it has been said they took as little notice of it as if it was invisible, but when a considerable number were introduced into a nest at once (twenty into a nest of mixed *Formica rufa* and *fusca*, or twelve into a nest of *Myrmica laevinodis*) they were at once attacked and massacred by the ants, except a few which were left to live and breed unmolested afterwards. Father Wasmann suggests that in these cases the Platyarthrus might either have been attacked before their peaceable character was recognised, or their sudden invasion in such large numbers may have caused alarm, or they may have brought with them a hostile odour from the ant's nest from which they had been taken.

[1] "Weitere Beiträge zum socialen Paratismus und der Sklaverei bei den Ameisen." Von E. Wasmann, S.J., Luxemburg (*Biologisches Centralblatt*, April 15, May 1, 15, June 1, and July 1).

Other observations on Lomechusa seem to show that the numbers of ant-guests are kept down to a moderate level, and if they become too numerous, they are killed off to reduce their numbers sufficiently to suit the ants, the survivors being protected. Indeed, some of the beetle-guests of the ants may live to the age of two or three years in the nests.

Other observations relate to mixed nests of *Formica exsecta* and *fusca*, which are met with in a state of nature. The development of such colonies, and their generally hostile treatment of Atemeles and other beetles, is discussed in detail.

Further observations relate to experiments on the rearing of other species of worker-pupæ in the nests of *Formica truncicola*, with similar experiments, for comparison, with other ants. While worker-pupæ of *F. fusca* are adopted and reared by *F. truncicola*, those of other species of ants are mostly destroyed, sooner or later, if they are introduced into their nests. It was noticed that some months after the reception of *F. fusca* into one of the nests the queen of *F. truncicola* had become perceptibly darker, but whether this was due to the presence of the darker species (*F. fusca*) or was merely the result of old age requires further investigation. Interesting observations are also recorded respecting the migration of ant colonies, and on their behaviour after the death of the queen.

Another section of the papers is devoted to experiments on the founding of colonies, with special reference to the parasitic and slave-holding species of Formica. Sometimes queens of one species are adopted into the nests of other species, but sometimes they are attacked and killed.

Further observations relate to the founding of colonies of Polyergus, Strongylognathus, and Anergates. Of these, the latter is the most interesting genus. These curious ants develop only into males and females, without workers, and live parasitically in the nests of ants of the genus Tetramorium, where their colonies are met with only rarely, but where they are found they are very numerous. The males are small and wingless. So much was previously known, and Father Wasmann's latest experiments do not throw much fresh light on the subject.

Finally, the author discusses the relationship between parasitism and slavery in ants (which he regards as closely connected), with special reference to Wheeler's views on the subject. These phenomena cannot be explained on phylogenetic principles, on account of the wide differences between the species, which often dwell together in mixed colonies. We have not sufficient space to follow this question further, but strongly recommend students who are interested in ants to wade through Father Wasmann's papers for themselves, for though the observations are sometimes tedious, and seem to us to include a good deal of superfluous detail, yet they include a great amount of material which must be taken into account by all who interest themselves in the numerous problems presented by the habits and psychology of ants. W. F. KIRBY.

RAYS OF POSITIVE ELECTRICITY.[1]

IN 1886 Goldstein discovered that when the kathode in a discharge-tube is perforated, rays pass through the openings and produce luminosity in the gas behind the kathode; the colour of the light depends on the gas with which the tube is filled, and coincides with the colour of the velvety glow which occurs immediately in front of the kathode. The appearance of these rays is indicated in Fig. 1, the anode being to the left of the kathode KK. Since the rays appeared through narrow channels in the kathode, Goldstein called them "Kanalstrahlen"; now that we know more about their nature, "positive rays" would, I think, be a more appropriate name. Goldstein showed that a magnetic force which would deflect kathode rays to a very considerable extent was quite without effect on the "Kanalstrahlen." By using intense magnetic fields, W. Wien showed that these rays could be deflected, and that the deflection was in the opposite direction to that of the kathode rays, indicating that these rays carry a positive charge of electricity. This was confirmed by measuring the electrical charge received by a vessel into which the rays passed through a small hole, and also by observing the direction in which they are deflected by an electric force. By measuring the deflections under magnetic and electric forces, Wien found by the usual methods the value of e/m and the velocity of the rays. He found for the maximum value of e/m the value of 10^4, which is the same as that for an atom of hydrogen in the electrolysis of solutions. A valuable summary of the properties of these rays is contained in a paper by Ewers ("Jahrbuch der Radioaktivität," iii., p. 291, 1906).

FIG. 1.

As these rays seem the most promising subjects for investigating the nature of positive electricity, I have made a series of determinations of the values of e/m for positive rays under different conditions. The results of these I will now proceed to describe.

Apparatus.

Screen used to Detect the Rays.—The rays were detected and their position determined by the phosphorescence they produced on a screen at the end of the discharge-tube. A considerable number of substances were examined to find the one which would fluoresce most brightly under the action of the rays. As the result of these trials willemite was selected. This was ground to a very fine powder and dusted uniformly over a flat plate of glass. Considerable trouble was found in obtaining a suitable substance to make the powder adhere to the glass. All gums, &c., when bombarded by the rays are liable to give off gas; this renders them useless for work in vacuum-tubes. The method finally adopted was to smear a thin layer of "water-glass" (sodium silicate) over the glass plate, and then dust the powdered willemite over this layer and allow the water-glass to dry slowly before fastening the plate to the end of the tube.

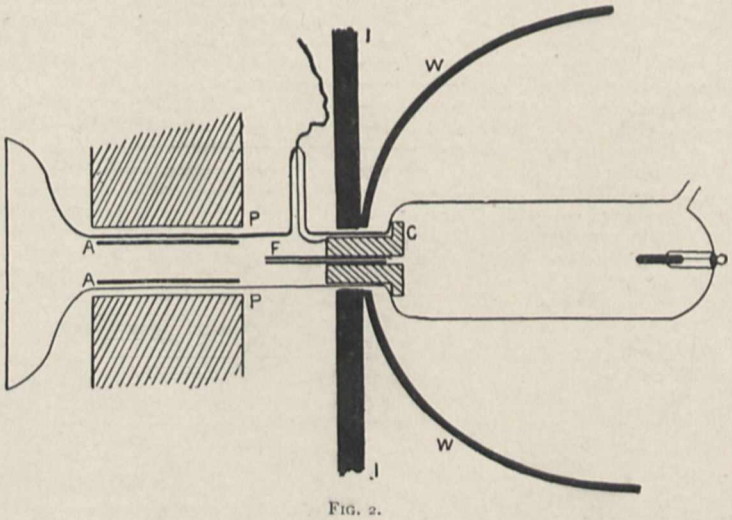


FIG. 2.

The form of tube adopted is shown in Fig. 2. A hole is bored through the kathode, and this hole leads to a very fine tube F. The bore of this tube is made as fine as possible, so as to get a small, well-defined fluorescent patch on the screen. These tubes were either carefully made glass tubes or else the hollow thin needles used for hypo-

[1] Discourse delivered at the Royal Institution by Sir J. J. Thomson, F.R.S.

dermic injections, which I find answer excellently for this purpose. After getting through the needle, the positive rays on their way down the tube pass between two parallel aluminium plates A A. These plates are vertical, so that when they are maintained at different potentials the rays are subject to a horizontal electric force, which produces a horizontal deflection of the patch of light on the screen. The part of the tube containing the parallel aluminium plates is narrowed as much as possible, and passes between the poles P P of a powerful electromagnet of the Du Bois type. The poles of this magnet are as close together as the glass tube will permit, and are arranged so that the lines of magnetic force are horizontal and at right angles to the path of the rays. The magnetic force produces a vertical deflection of the patch of phosphorescence on the screen. To bend the positive rays it is necessary to use strong magnetic fields, and if any of the lines of force were to stray into the discharge-tube in front of the kathode they would distort the discharge in that part of the tube. This distortion might affect the position of the phosphorescent patch on the screen, so that unless we shield the discharge-tube we cannot be sure that the displacement of the phosphorescence is entirely due to the electric and magnetic fields acting on the positive rays after they have emerged from behind the kathode.

To screen off the magnetic field the tube was placed in a soft iron vessel W with a hole knocked in the bottom, through which the part of the tube behind the kathode was pushed. Behind the vessel a thick plate of soft iron with a hole bored through it was placed, and behind this again as many thin plates of soft iron, such as are used for transformers, as there was room for, were packed. When this was done it was found that the magnet produced no perceptible effect on the discharge in front of the kathode.

The object of the experiments was to determine the value of e/m by observing the deflection produced by magnetic and electric fields. When the rays were undeflected they produced a bright spot on the screen; when the rays passed through electric and magnetic fields the spot was not simply deflected to another place, but was drawn out into bands or patches, sometimes covering a considerable area. To determine the velocity of the rays, and the value of e/m, it was necessary to have a record of the shape of these patches. This might have been done by substituting a photographic plate for the willemite screen. This, however, was not the method adopted, as, in addition to other inconveniences, it involves opening the tube and re-pumping for each observation, a procedure which would have involved a great expenditure of time. The method actually adopted was as follows:—The tube was placed in a dark room from which all light was carefully excluded, the tube itself being painted over, so that no light escaped from it. In these circumstances the phosphorescence on the screen appeared bright and its boundaries well defined. The observer traced in Indian ink on the outside of the thin flat screen the outline of the phosphorescence. When this had been satisfactorily accomplished the discharge was stopped, the light admitted into the room, and the pattern on the screen transferred to tracing-paper; the deviations were then measured on these tracings.

Calculation of the Magnetic and Electric Deviation of the Rays.

If we assume the electric field to be uniform between the plates and zero outside them, then we can easily show that x, the horizontal deflection of a ray the charge of which is e, mass m, and velocity v, is given by the equation

$$x=\tfrac{1}{2}\mathrm{X}\frac{e}{mv^2}l(l+2d),$$

where X is the force between the plates, l the length of path of the rays between the plates, and d the distance of the screen from the nearer end of the parallel plates.

To find the deflection due to the magnetic field, we have, if ρ is the radius of curvature of the path at a point where the magnetic force is H,

$$\frac{mv^2}{\rho}=\mathrm{H}ev,$$

or

$$\frac{1}{\rho}=\frac{e}{mv}\mathrm{H}.$$

If y is the vertical displacement of the particle, we have

$$\frac{1}{\rho}=\frac{d^2y}{dz^2}\text{ approximately,}$$

where z is measured along the path of the ray. Hence

$$\frac{d^2y}{dz^2}=\frac{e}{mv}\mathrm{H};$$

$$y=\frac{e}{mv}\left[\int_0^{l+d}\int_0^z \mathrm{H}dz\right] \quad . \quad . \quad . \quad . \quad (1)$$

In these strong fields there are considerable variations of H along the path, so that to calculate the integrals we should have to map out the value of H along the path of the ray. This would be a very laborious process, and it was rendered unnecessary by the following simple method, which, while not involving anything like the labour of the direct method, gives much more accurate results. The method is shown in Fig. 3. The part of the tube through which the rays pass was cut off, and a metal rod placed so that its tip Z coincided with the aperture of the narrow tube through which the positive rays had emerged. A very fine wire soldered to the end of this tube passed over a light pulley, and carried a weight at the free end. The pulley was supported by a screw, by means of which it could be raised or lowered; a known current passed through the wire, entering it at Z and leaving it through the pulley. The pulley was first placed so that the path of the stretched wire when undeflected by a magnetic field coincided with the path of the undeflected rays. A vertical scale, the edge of which was at the same distance from the opening through which the rays emerge as the screen on which the phosphorescence had been observed, was placed

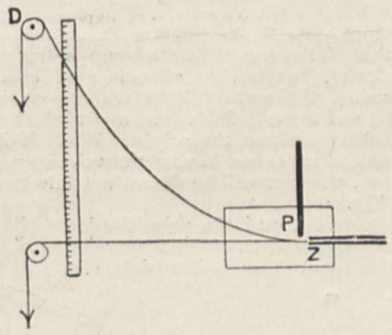


FIG. 3.

just behind the wire, and was read by a reading microscope with a micrometer eye-piece. When the magnetic field was put on, the wire was deflected; and if T is the tension of the wire, ρ the radius or curvature into which it is bent, i the current through the wire,

$$\frac{\mathrm{T}}{\rho}=\mathrm{H}i;$$

or, if y_1 is the vertical displacement of the wire,

$$\frac{d^2y_1}{dz^2}=\frac{i}{\mathrm{T}}\cdot\mathrm{H}$$

Now if $\frac{dy_1}{dz}=0$ when $z=0$ we have, if y_1 is the displacement of the wire at the scale,

$$y_1=\frac{i}{\mathrm{T}}\int_0^l\cdot\int_0^z \mathrm{H}dz \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Hence, comparing (1) and (2) we have

$$\frac{y}{y_1}=\frac{\frac{e}{mv}}{\frac{i}{\mathrm{T}}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

a relation from which the magnetic force is eliminated. To ensure that the tangent to the wire is horizontal when $z=0$, the following method is used. P is a chisel-edge carried by a screw and placed about 1 mm. in front of the fixed end of the wire; this is adjusted so that when the magnetic field is not on, the wire just touches the edge; this can be ascertained by making the contact with the wire complete an electric circuit in which a bell is placed. When the magnetic field is put on the wire is pulled off from the edge, and the tangent at $z=0$ is no longer horizontal; it can, however, be brought horizontal by raising or lowering the pulley D until the wire is again in contact with P, which can be ascertained again by the ringing of the bell. Then y_1 is the vertical distance between the point where the wire now crosses the edge of the scale and the point where it crossed it before the magnetic field was put on. Since y, y_1, i, and T can easily be measured, equation (3) gives us the value of e/mv, while the deflection under the electric force gives the value of e/mv_2.

If y is the vertical displacement of the patch of phosphorescent light on the screen produced by the magnetic field, x the horizontal displacement due to the electrostatic field, we see that

$$y=\frac{y_1}{\left(\frac{i}{T}\right)}\frac{e}{mv}=B\frac{e}{mv},$$

$$x=A\frac{e}{mv^2},$$

where A and B are constants depending on the position of the screen and the magnitudes of the electric and magnetic forces. These quantities can be calculated by means of the equations just given.

Since

$$\frac{y}{x}=\frac{B}{A}v,$$

$$\frac{y^2}{x}=\frac{B^2}{A}\frac{m}{e}.$$

We see that if the pencil is made up of rays having a constant velocity, but having all values of e/m up to a maximum value, the spot of light will be spread out by the magnetic and electric fields into a straight line extending a finite distance from the origin. While if it is made up of two sets of rays, one having the velocity v_1 the other the velocity v_2, the spot will be drawn out into two straight lines as in Fig. 4.

If e/m is constant and the velocities have all values up to a maximum, the spot of light will be spread out into a portion of a parabola as indicated in Fig. 5.

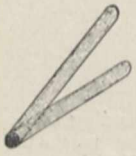


FIG. 4.

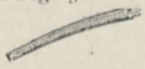


FIG. 5.

We shall later on give examples of each of these cases.

The discharge was produced by means of a large induction coil, giving a spark of about 50 cm. in air, with a vibrating make and break apparatus. Many tubes were used in the course of the investigation; the dimensions of these varied slightly. The distance of the screen from the hole from which the rays emerged was about 9 cm., the length of the parallel plates about 3 cm., and the distance between them 0·3 cm.

Properties of the Positive Rays when the Pressure is not exceedingly low.

The appearance of the phosphorescent patch after deflection in the electric and magnetic fields depends greatly upon the pressure of the gas. I will begin by considering the case when the pressure is comparatively high, say of the order of 1/50 mm. At these pressures, though the walls of the tube in front of the kathode were covered with bright phosphorescence and the dark space extended right up to the walls of the tube, and was several centimetres thick, traces of the positive column could be detected in the neighbourhood of the anode. I will first take the case where the tube was filled with air. Special precautions were taken to free the air from hydrogen; it was carefully dried, and a subsidiary discharge-tube, having a kathode made of the liquid alloy of sodium and potassium, was fused on to the main tube. When the discharge passes from such a kathode it absorbs hydrogen. The discharge was sent through this tube at the lowest pressure at which enough light was produced in the gas to give a visible spectrum, until the hydrogen lines disappeared and the only lines visible were those of nitrogen and mercury vapour. This pressure was a little higher than that used for the investigation of the positive rays, but a pump or two was sufficient to bring the pressure down to this value. The appearance of the phosphorescence on the screen when the rays were deflected by magnetic and electric forces separately and conjointly is shown in Fig. 6.

The deflection under magnetic force alone is indicated by vertical shading, under electric force alone by horizontal shading, and under the two combined by cross shading.

The spot of phosphorescence is drawn out into a band on either side of its original position. The upper portion, which is very much the brighter, is deflected in the direction which indicates that the phosphorescence is produced by rays having a positive charge; the lower portion (indicated by dots in the figure), which though faint is quite perceptible on the willemite screen, is deflected as if *the rays carried a negative charge*. The length of the lower portion is somewhat shorter than that of the upper one, but is quite comparable with it. The intensity of the luminosity in the upper portion is at these pressures quite continuous; no abrupt variations such as would show themselves as bright patches could be detected, although, as will be seen later on, these make their appearance at lower pressures. Considering for the present the upper portion, the straightness of the edges shows that the velocity of the rays is approximately constant, while the values of e/m range from zero at the undeflected portion to the value approximately equal to 10^4 at the top of the deflected band. This value of e/m is equal to that for a charged hydrogen atom, and, moreover, there was no specially great luminosity in the positions corresponding to $e/m=10^4/14$ and $10^4/16$, the values for rays carried by nitrogen or oxygen atoms, though these places were carefully scrutinised. As hydrogen when present as an impurity in the tube has a tendency to accumulate near the kathode, the following experiment was tried to see whether the Kanalstrahlen were produced from traces of hydrogen in the tube. The discharge was sent through the tube in the opposite direction, *i.e.* so that the perforated electrode was the anode, the electric and magnetic fields being kept on. When the discharge passed in this way there was, of course, no luminosity on the screen; on reversing the coil again, so that the perforated electrode was the kathode, the luminosity flashed out instantly, presenting exactly the same appearance as it had done when the tube had been running for some time with the perforated electrode as kathode.

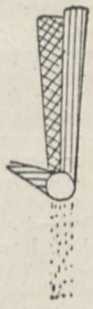


FIG. 6.

The fact that a spot of light produced by the undeflected positive rays is under the action of electric and magnetic forces drawn out into a continuous band was observed by W. Wien, who was the first to measure the deflection of the positive rays under electric and magnetic forces. The values of e/m obtained from the deflections of various parts of this band range continuously from zero, the value corresponding to the undeflected portion, to 10^4, the value corresponding to those most deflected. Wien explained this by the hypothesis that the charged particles which make up the positive rays act as nuclei, round which molecules of the gas through which the rays pass condense, so that very complex systems made up of a very large number of molecules get mixed up with the particles forming the positive rays, and that it is these heavy and cumbrous systems which give rise to that part of the luminosity which is only slightly deflected. I think that

the constancy of the velocity of the rays, indicated by the straight edges of the deflected band, is a strong argument against this explanation, and that the existence of the negative rays is conclusive against it. These negatively electrified rays, which form the faintly luminous portion of the phosphorescence indicated in Fig. 6, are not kathode rays. The magnitude of their deflection shows that the ratio of e/m for these rays, instead of being as great as $1{\cdot}7\times10^7$, the value for kathode rays, is less than 10^4. The particles forming these rays are thus comparable in size with those which form the positive rays. The existence of these negatively electrified rays suggests at once an explanation, which I think is the true one, of the continuous band into which the spot of phosphorescence is drawn out by the electric and magnetic fields. The values of e/m which are determined by this method are really the mean values of e/m, while the particle is in the electric and magnetic fields. If the particles are for a part of their course through these fields without charge, they will not during this part of their course be deflected, and in consequence the deflections observed on the screen, and consequently the values of e/m, will be smaller than if the particle had retained its charge during the whole of its career. Thus, suppose that some of the particles constituting the positive rays, after starting with a positive charge, get this charge neutralised by attracting to them a negatively electrified corpuscle, the mass of the corpuscle is so small in comparison with that of the particle constituting the positive ray that the addition of the particle will not appreciably diminish the velocity of the positive particle. Some of these neutralised particles may get positively ionised again by collision, while others may get a negative charge by the adhesion to them of another corpuscle, and this process might be repeated during the course of the particle. Thus there would be among the rays some which were for part of their course unelectrified, at other parts positively electrified, and at other parts negatively electrified. Thus the mean value of e/m might have all values ranging from α, its initial value, to $-\alpha'$, where α' might be only a little less than α. This is just what we observe, and when we remember that the gas through which the rays are passing is ionised, and contains a large number of corpuscles, it is, I think, what we should expect.

At very low pressures, when there are very few ions in the gas, this continuous band stretching from the origin is replaced by discontinuous patches.

Positive Rays in Hydrogen.

In hydrogen, when the pressure is not too low, the brightness of the phosphorescent patch is greater than in air at the same pressure; the shape of the deflected phosphorescence is markedly different from that in air. In air, the deflected phosphorescence is usually a straight band, whereas in hydrogen the boundary of the most deflected side is distinctly curved and is concave to the undeflected position. The appearance of the deflected phosphorescence is indicated in Fig. 7.

The result indicated in Fig. 8, which was also obtained

FIG. 7.

FIG. 8.

with hydrogen, shows that we have here a mixture of two bands, as indicated in Fig. 4, the two bands being produced by carriers having different maximum values of e/m. The greatest value of e/m obtained with hydrogen was the same as in air, $1{\cdot}2\times10^4$, the velocity was $1{\cdot}8\times10^8$ cm. per sec. The presence of the second band indicates that mixed with these we have another set of carriers, for which the maximum value e/m is half that in the other band, *i.e.* 5×10^3. The curvature of the boundary generally observed is due to the admixture of these two rays.

Positive Rays in Helium.

In helium the phosphorescence is bright, and the deflected patch has in general the curved outline observed in hydrogen. I was fortunate enough, however, to find a stage in which the deflected patch was split up into two distinct bands, as shown in Fig. 9. The maximum value of e/m in the band a was $1{\cdot}2\times10^4$, the same as in air and hydrogen, and the velocity was $1{\cdot}8\times10^8$, while the maximum value of e/m in band b was almost exactly one quarter of that in a (*i.e.* $2{\cdot}9\times10^3$). As the atomic weight of helium is four times that of hydrogen, this result indicates that the carriers which produce the band b are atoms of helium. This result is interesting, because it is the only case (apart from hydrogen) in which I have found values of e/m corresponding to the atomic weight of the gas; and even in the case of helium, when the pressure in the discharge-tube is very low and the electric field very intense, the characteristic rays with $e/m=2{\cdot}9\times10^3$ sometimes disappear, and, as in all the gases I have tried, we get two sets of rays, for one set of which $e/m=10^4$ and for the other 5×10^3.

FIG. 9.

Although the helium had been carefully purified from hydrogen, the band a (for which $e/m=10^4$) was generally the brighter of the two. The case of helium is an interesting one; for the class of positive rays, known as the α rays, which are given off by radio-active substances, would *a priori* seem to consist most probably of helium, since helium is one of the products of disintegration of these substances. The value of e/m for these substances is 5×10^3, where we have seen that in helium it is possible to obtain rays for which $e/m=2{\cdot}9\times10^3$. It is true that, at very low pressures and with strong electric fields, we get rays for which $e/m=5\times10^3$; but this is not a peculiarity of helium; all the gases which I have tried show exactly the same effect.

Argon.

When the discharge passed through argon, the effects observed were very similar to those occurring in air. The sides were perhaps a little more curved, and there was a tendency for bright spots to develop. The measurements of the electric and magnetic deflection of these spots gave $e/m=10^4$, the value obtained for other cases. There was no appreciable increase of luminosity in the positions corresponding to $e/m=10^4/40$, as there would have been if an appreciable number of the carriers had been argon atoms.

Positive Rays in Gases at very low Pressures.

As the pressure of the gas in the discharge-tube is gradually reduced, the appearance of the deflected phosphorescence changes; instead of forming a continuous band, the phosphorescence breaks up into two isolated patches; that part of the phosphorescence in which the deflection was very small disappears, as also does the phosphorescence produced by the negatively electrified portion of the rays.

In the earlier experiments considerable difficulty was experienced in working at these very low pressures; for when the pressure was reduced sufficiently to get the effects just described, the discharge passed through the tube with such difficulty that in a very few seconds after this stage was reached sparks passed from the inside to the outside of the tube, perforating the glass and destroying the vacuum. In spite of all precautions, such as earthing the kathode and all conductors in its neighbourhood, perforation took place too quickly to permit measurements of the deflection of the phosphorescence.

This difficulty was overcome by taking advantage of the fact that, when the kathode is made of a very electropositive metal, the discharge passes with much greater ease than when the kathode is made of aluminium or platinum.

The electropositive metals used for the kathode were:—(1) the liquid alloy of sodium and potassium, which was smeared over the kathode, and (2) calcium, a thin plate of which was affixed to the front of the kathode. With these kathodes, the pressure in the tube could be reduced to very low values without making the discharge so difficult as to lead to perforation of the tube by sparking, and accurate measurements of the position of the patches of phosphorescence could be obtained at leisure.

The results obtained at these low pressures are very interesting. Whatever kind of gas may be used to fill the tube, or whatever the nature of the electrode, the deflected phosphorescence splits up into two patches. For one of these patches the maximum value of e/m is about 10^4, the value for the hydrogen atom; while the value for the other patch is about 5×10^3, the value for α particles or the hydrogen molecule. Examples of the appearance of this phosphorescence are given in Figs. 10, 11, and 12. In Fig. 12 the magnetic force was reversed.

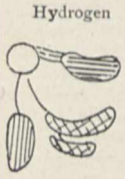


FIG. 10.

FIG. 11.

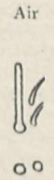


FIG. 12.

The differences in the appearance are due to differences in the pressure rather than to differences in the gas; for at slightly higher pressures than that corresponding to Fig. 12, the appearance shown in Figs. 10 and 11 can be obtained in air. In all these cases the more deflected patch corresponds to a value of about 10^4 for e/m, while e/m for the less deflected patch is about 5×10^3.

It will be noticed that in Fig. 11 there is no trace in the helium tube of rays for which $e/m=2\cdot5\times10^3$, which were found in helium tubes at higher pressures; at intermediate pressures there are *three* distinct patches of helium, for the first of which $e/m=10^4$, for the second $e/m=5\times10^3$, and for the third $e/m=2\cdot5\times10^3$ approximately. Helium is a case where there are characteristic rays—*i.e.* rays for which $e/m=10^4/M$, where M is the atomic weight of the gas, when the discharge potential is comparatively small, and not when, as at very low pressures, the discharge potential is very large. I think it very probable that, if we could produce the positive rays with much smaller potential differences than those used in these experiments, we might get the characteristic rays for other gases. I am at present investigating with this object the positive rays produced when the perforated kathode is, as in Wehnelt's method, coated with lime, when a potential difference of 100 volts or less is able to produce positive rays. The interest of the experiments at very low pressures lies in the fact that in this case the rays are the same whatever gas may be used to fill the tube; the characteristic rays of the gas disappear, and we get the same kind of carriers for all substances.

I would especially direct attention to the simplicity of the effects produced at these low pressures; only two patches of phosphorescence are visible. This is, I think, an important matter in connection with the interpretation of these results; for at these low pressures we have to deal, not only with the gas with which the tube was originally filled, but also with the gas which is given off by the electrodes and the walls of the tube during the discharge; and it might be urged that at these low pressures the tube contained nothing but hydrogen given out by the electrodes. I do not think this explanation is feasible, for the following reasons:—

(1) The gas developed during the discharge is not wholly hydrogen; if the discharge is kept passing long enough to develop so much gas that the discharge through the gas is sufficiently luminous to be observed by a spectroscope, the spectrum always showed, in addition to the hydrogen lines, the nitrogen bands; indeed, the latter were generally the most conspicuous part of the spectrum. If the phosphorescent screen on which the positive rays impinge is observed during the time this is being given off, the changes which take place in the appearance of the screen are as follows:—If, to begin with, the pressure is so slow that the phosphorescent patches are reduced to two bright spots, then, as the pressure begins to go up owing to the evolution of the gas, the deflection of the spots increases. This is owing to the reduction in the velocity of the rays consequent upon the reduction of the potential difference between the terminals of the tube, as at this stage an increase in the pressure facilitates the passage of the discharge. In addition to the increase in the displacement there is an increase in the area of the spots giving a greater range of values of e/m; this is owing to the increase in the number of collisions made by the particles in the rays on their way to the screen. As more and more gas is evolved the patches get larger, and finally overlap; the existence of the second patch being indicated by a diminution in the brightness of the phosphorescence at places outside its boundary. As the pressure increases the luminosity gets more and more continuous, and we finally get to the continuous band, as shown in Fig. 6. At this stage it is probable that there may be enough luminosity to give a spectrum showing the nitrogen lines, indicating that a considerable part of the gas in the tube is air. It is especially to be noted that during this process, when gas was coming into the tube, there has been no development of patches in the phosphorescence indicating the presence of new rays; on the contrary, one type of carrier—that corresponding to $e/m=5\times10^3$—has disappeared. The presence of the nitrogen bands in the spectrum shows that nitrogen is carrying part of the discharge, and yet there are no rays characteristic of nitrogen to be observed on the screen, a proof, it seems to me, that different gases may be made by strong electric fields to give off the same kind of carriers of positive electricity.

Another result, which shows that the positive rays are the same although the gases are different, is the following. The tube was pumped until the pressure was much too low for the discharge to pass, then small quantities of the following gases were put into the tube:—air, carbonic oxide, hydrogen, helium, neon (for which I am indebted to the kindness of Sir James Dewar); the quantity admitted was adjusted so that it was sufficient to cause the discharge to pass, and yet did not raise the pressure beyond the point where the phosphorescence is discontinuous. In every case there were patches corresponding to $e/m=10^4$, $e/m=5\times10^3$, and except with helium these were the only patches; in helium, in addition to the two already mentioned, there was a third patch, for which $e/m=2\cdot5\times10^3$.

I also tried another method of ensuring that at these low pressures there were other gases besides hydrogen in the tube. I filled the tube with helium, and after exhausting to a fairly low pressure by means of the mercury pump, I performed the last stages of the exhaustion by means of charcoal cooled with liquid air. This charcoal absorbs very little helium in comparison with other gases, so that it is certain that there was helium in the tube. The appearance of the phosphorescent screen of tubes exhausted in this way did not differ from those exhausted solely by the pump.

The most obvious explanation of these effects seems to me to be that under very intense electric fields different substances give out particles charged with positive electricity, and that these particles are independent of the nature of the gas from which they originate. These particles are, so far as we know at present, of two kinds; for one kind e/m has the value of 10^4, that of an atom of hydrogen; for the other kind e/m has half this value, *i.e.* it has the same value as for the α particles from radioactive substances.

This agreement in the maximum value of e/m at different pressures is a proof that this is a true maximum, and that there are not other more deflected rays not strong enough to produce visible phosphorescence; for if this were the case—*i.e.* if the value of e/m for a particle that had never lost its charge temporarily by collision were greater than 10^4—we should expect to get larger values for e/m at low pressures than at high.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE New York correspondent of the *Times* announces that Dr. Charles W. Eliot's resignation of the presidency of Harvard University will take effect in May next.

MISS HOLLAND WREN has been appointed by the council of the Pharmaceutical Society demonstrator in the society's School of Pharmacy. This is the first time a woman has been appointed to such a position since the school was established more than sixty years ago.

THE current number of *Child Study*, the journal of the Child Study Society, which is published quarterly, contains an article by Dr. Alex. Morgan, principal of the Provincial Training College, Edinburgh, on child study in relation to the training of teachers. Dr. Morgan thinks there is a tendency to over-estimate the practical utility at the present time of psychology in education, and though he hopes the time will come when we shall have a scientific pedagogy founded entirely on a scientific psychology, he is of opinion that this day is not imminent.

IT is stated in the *Pioneer Mail* that Mr. Chinubhai Madhowlal has given four lakhs of rupees in 3½ per cent. Government securities to be applied by the Government towards the development of science teaching in Ahmedabad, in connection, if possible, with the proposed Curline Institute in Bombay. The Governor, in acknowledging the gift, is reported to have said that the response to his appeal for means to develop science teaching in the Presidency is far more generous than he had dared to hope, and the splendid benefactions, amounting to eighteen lakhs, prove alike the large-hearted patriotism of the givers and their recognition of one of India's greatest educational needs.

THE Department of Agriculture and Technical Instruction for Ireland has re-published in pamphlet form an article by Mr. A. E. Easthope, principal of the technical schools and organising secretary for technical instruction in the county of Louth, on technical instruction in Dundalk. The article originally appeared in the department's Journal (vol. viii., No. 4). This is the sixth of a short series of articles on recently established Irish technical schools. The Municipal Technical School, Dundalk, is housed in a new building specially erected for the purpose, and Mr. Easthope's description and the illustrations of various departments of the school serve admirably to illustrate the progress being made in this department of Irish education.

THE report for the year ending on June 30 last of Mr. Charles Madeley, director and librarian for the Warrington Museum Committee, shows that the educational work in connection with the museum continues to be developed. There was during the year a notable increase in the number of accessions to the museum. Continued interest is taken in the wild-flower table, which is a distinctive feature of the work done at Warrington. The average number of species on view during July to October was 175, the maximum, 200 species, being reached on September 4. In the autumn the flowers were succeeded by fruits and seeds. Personal observation has proved that the number of persons making regular visits for the purpose of studying these plant specimens is on the increase, and the number of inquiries for botanical information continues to grow. Additions have also been made to the specially arranged educational exhibits, particularly in the botanical gallery and the department of invertebrate animals. It is to be hoped that the authorities of more provincial museums may follow the example of Warrington and make their exhibits serve an educational purpose of a definite kind.

THE calendar of University College (University of London) for the session 1908–9 has just been issued. It contains many new features. The outline of the history of the college, by Dr. Carey Foster, has been revised and brought up to date. The calendar also contains a set of plans that show more completely than before the uses to which the extension of buildings is being put. The new buildings have resulted in extended accommodation for the libraries, for the faculty of arts, for the departments of geology, hygiene, experimental psychology, and for each of the departments of the faculty of engineering. The calendar also contains a section setting forth in full the arrangements for post-graduate courses of lectures and the facilities for research work. The regulation with regard to admission is as follows:—"On the recommendation of the professor of any department, any student qualified to undertake research work may be admitted to the college for the purpose of undertaking such work. Each student so admitted shall pay in the office a registration fee of 1*l.* 1*s.* per session, and such other fee (if any) as the regulations of the department may require, and shall bear the cost (if any) of his work." It appears from the summary of students that there were no fewer than 229 post-graduate and research students in the college last session.

THE annual general meeting of the Association of Teachers in Technical Institutions was held on November 7 at St. Bride's Institute, Bride Lane, London. In moving the adoption of the report, Mr. Charles Harrap, the president, congratulated the members on the steady progress which has been made. He went on to say it is time there was a technical college for training teachers. No one knows better than the members of the association how difficult it is to get competent technical handicraft teachers —men who have worked at the trade and know how to teach it. Such men, when found, deserve the best treatment from authorities in order that they may be retained for the benefit of technical instruction generally. Among the difficulties which have to be overcome if English technical education is to be successful is the necessity of obtaining the concurrence of both employers and employees in any scheme intended to substitute trade-school training for part or whole apprenticeship. The London County Council has been able to form two consultative committees, one for the bookbinding and another for the printing trades, each committee consisting of three employers, three representatives of the employees, and three London County Council nominees. One of these committees has completed its preliminary work, and in due course an experimental school is to be tried where lads can undergo a proper preparatory training for the trade. The youths will generally be selected by scholarship tests, and may enter the preparatory trade training school from 12½ years of age. The newly elected president of the association is Mr. J. Wilson, head of the chemical department, Battersea Polytechnic, S.W., who has acted as honorary secretary of the association since its formation in 1904. His successor in that office is Mr. P. Abbott, head of the mathematical department, Regent Street Polytechnic, London, W.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 25.—"Eutectics Research, No 1. The Alloys of Lead and Tin." By Walter **Rosenhain**, with P. A. **Tucker**. Communicated by Dr. R. T. Glazebrook, F.R.S.

Attempts to prepare pure eutectic alloys led to the discovery of discrepancies between the authors' experiments and the data on lead-tin alloys published by Roberts-Austen. The present paper contains an account of the complete re-determination of the equilibrium diagram of the lead-tin series. The eutectic point is now placed at 63 per cent. of tin, and the eutectic line ends, towards the lead end of the series, at 16 per cent. of tin, while a series of transformations in the solid alloys, with a maximum temperature lying at 150° C., has been discovered. By the aid of levigated oxide of chromium the alloys have been polished for microscopic examination, and this has enabled the authors to decide many points with greater accuracy. For the purposes of microscopic examination, and also for cooling-curve purposes, specimens of the alloys were kept at temperatures of 175° C. for periods up to six weeks, and some were quenched in liquid air. Cooling and heating curves ranging down to −180° C. were also taken. By these means it was shown that the transformation above mentioned consists in a change in the solid solution of tin in lead, which passes from a β into an α condition, at the same time rejecting tin from solution.

The structures observed in lead-tin eutectic alloys are described in detail, and evidence is given for the view that this alloy consists of an aggregate of spherulitic crystals. The authors have also examined the structure of "alloys" prepared by the compression of powders (Spring's method), and have found them to consist of aggregates of the original particles in an unchanged condition.

"The Boiling Point of Sulphur on the Constant Pressure Air Thermometer." By N. **Eumorfopoulos.** Communicated by Prof. H. L. Callendar, F.R.S.

The experiments described in this paper were carried out with a view to the re-determination of the boiling point of sulphur, the value (444°·53) previously obtained by Callendar and Griffiths being open to some doubt.

The air thermometer, made of Jena glass 16 III., is substantially that described by Callendar (Roy. Soc. Proc., vol. l., p. 247), except that the final adjustment of pressure is made with the help of an oil gauge.

The formula to be used with this thermometer is shown to take a simple form, the necessary corrections being small. In particular, the uncertainty of the temperature of the "dead space" is eliminated by means of compensated tubes. The sensitiveness of the oil gauge is given for different temperatures, and its diminution with rise of temperature shown to have little practical importance.

All the volume determinations are made with mercury. The expansion of the bulb was obtained by treating it as a weight thermometer, observations being made at 0°, 100°, and 184°. If the Regnault-Broch formula for the expansion of mercury is taken, the experiments lead to the following expression for the coefficient of expansion of the glass,

$$\{23868 + 4\cdot20(t - 100)\}10^{-9},$$

but with Chappuis's value to

$$\{24254 + 23\cdot47(t - 100)\}10^{-9}.$$

Reasons are given for preferring the former value, thus suggesting that the true value for the coefficient of expansion of mercury is still unknown.

The boiling point of sulphur was determined directly on the air thermometer; the mean of the eleven values obtained is, at normal pressure, 443°·62.

The changes of volume of the bulb when heated in sulphur vapour were a source of trouble and some uncertainty, although the bulb had been previously annealed for many hours.

"Note on the Boiling Point of Sulphur." By Prof. H. L. **Callendar,** F.R.S.

One of the chief difficulties in the accurate determination of high temperatures by means of the gas thermometer is the uncertainty of the correction for the expansion of the bulb. The whole correction may amount to as much as 5° C. at 445° C. (the boiling point of sulphur) or 30° C. at 1000° C. The uncertainty of the correction is due to the fact that it cannot be directly determined, but must be inferred from observations of the linear expansion of the material of the bulb, or from observations with a mercury weight thermometer, in which the expansion of mercury is assumed. There are obvious objections to assuming that the cubical coefficient of expansion of an asymmetrical bulb is three times the linear. The method of the mercury weight thermometer would be theoretically perfect but for the fact that the temperature range available is somewhat restricted, and that the absolute expansion of mercury is more or less uncertain. The extrapolation of the observations beyond 300° C. is attended with some uncertainty, and the differences of the formulæ proposed to represent the expansion of mercury, though inconsiderable at low temperatures, become important when extrapolated. The value of the boiling point of sulphur hitherto assumed as the basis of the platinum scale of temperature, namely, 444°·53 C., depends on the determination of the correction by the linear expansion method alone. It appeared desirable to corroborate this result by the weight thermometer method.

With this object, Mr. Eumorfopoulos undertook a series of observations with a very delicate gas thermometer of Jena glass, the bulb of which was fitted to serve also as a mercury weight thermometer. The results of the several independent series of observations agreed among themselves to less than a tenth of a degree at the boiling point of sulphur, but differed by about 2° C. in the absolute value of the boiling point according as the formula of Regnault or that of Chappuis was adopted for the expansion of mercury. The value, according to Regnault's formula, was 443°·6 C., but it was 445°·8 C. according to the formula of Chappuis. Arrangements have in the meantime been made for the re-determination of the absolute expansion of mercury at the Royal College of Science, and it is hoped that the results of this work, which will be applicable to the reduction of previous observations, such as those of Mr. Eumorfopoulos, will reduce materially the present uncertainty.

"The Spectrum of Scandium and its Relation to Solar Spectra." By Prof. A. **Fowler.** Communicated by Sir William Crookes, F.R.S.

The greater part of this investigation of the spectrum of scandium under different experimental conditions has been based on purified scandia, generously placed at the author's disposal by Sir William Crookes. The principal results are as follows:—

(1) The arc spectrum of scandium consists of two distinct sets of lines, which behave very differently in solar spectra. Each set includes both strong and faint lines.

(2) Lines belonging to one set correspond with the enhanced lines of other elements, notwithstanding that they appear strongly in the ordinary arc spectrum:—(*a*) these lines are very feeble or missing from the arc-flame spectrum, and are strengthened in passing to the arc, the arc in hydrogen, or the spark; (*b*) they occur as relatively strong lines in the Fraunhofer spectrum; (*c*) they are weakened in the sun-spot spectrum; (*d*) they occur as high-level lines in the chromosphere.

(3) The remaining lines show a great contrast when compared with the first group:—(*a*) they are relatively strong lines in the arc flame; (*b*) they are very feebly represented in the Fraunhofer spectrum; (*c*) the stronger lines are prominent in the sun-spot spectrum; (*d*) they have not been recorded in the spectrum of the chromosphere.

(4) The special development of the enhanced lines in the Fraunhofer spectrum, together with their presence in the upper chromosphere, indicates that the greater part of the scandium absorption in the solar spectrum originates at a higher level than that at which the greater part of the iron absorption is produced.

(5) The discussion of scandium lines indicates that while in the case of some elements solar identifications are to be based chiefly on arc lines, in others it is the enhanced lines which may be expected to show the most important coincidences.

(6) The flutings which occur in the arc and arc flame do not appear when the arc is passed in an atmosphere of hydrogen. As suggested by Thalén, they are probably due to oxide of scandium.

Tables are given which show the lines of the arc spectrum from 3930 to 6580, the positions of the oxide flutings, and comparisons of the principal lines of the two classes with the sun, sun-spots, and chromosphere.

EDINBURGH.

Royal Society, November 2.—Prof. A. Gray, vice-president, in the chair.—Temperature observations on Loch Garry: E. M. **Wedderburn.** The observations were made during the first seven months of 1908 by means of reversing mercury thermometers, and led to the following general results:—(1) the observations give a complete series for the time of year during which the lake is gaining heat, so that comparisons may be made between Loch Garry, of comparatively small size, and Loch Ness, of much larger size; (2) they show the apparently fortuitous manner in which freezing may take place in the larger temperate lakes; (3) they show how strong winds have the effect of producing currents at considerable depths; (4) they prove that the formation of the discontinuity temperature layer in a lake occurs whenever the surface layer begins to cool; (5) they establish the existence of a temperature seiche in small temperate lakes like Loch Garry, and show that

this temperature oscillation may exist even when the discontinuity is not pronounced. The attempts to measure the ordinary seiche in Loch Garry were not very successful, the seiches being irregular and difficult to measure. The periods indicated were 10·5–11·1 minutes for the uninodal and about 5·5 minutes for the binodal.—The discharge of water from circular weirs and orifices: G. H. **Gulliver.** The elliptic integral which gives the discharge was computed graphically, and the results compared with experiment. Curves were drawn showing the relation between the discharge and the head. The observational and theoretical curves were of the same form, and were practically straight for heads between the centre and top of the circular aperture. This suggests that a circular weir, if kept more than half full yet not completely drowned, might be usefully employed in gauging streams. With the orifice of 2½ inches diameter used in the experiments, the discharge in gallons per minute was given by the formula $11H-0{\cdot}8$, where H is the head in inches above the lowest point of the orifice.—Dissymmetrical separations in the Zeeman effect in tungsten and molybdenum: Dr. Robert **Jack.** The relative intensities of the components of a Zeeman triplet depend upon polarisation effects of the grating in relation to the polarised state of the light. The experiments showed that concurrently with the change in the intensities of triplets for different parts of the spectrum there is a change in the type of dissymmetry. As the middle component passes through its minimum value there is a change from the normal dissymmetry (middle component nearer the red side component) to the abnormal dissymmetry (middle component nearer the violet side component). The dissymmetry could not be entirely accounted for by the angular position between the lines of the grating and the planes of vibration of the components. Voigt's theory based on the presence of couplings between electrons of different vibration period seemed to explain the phenomena sufficiently.—A question in absorption spectroscopy: Dr. R. A. **Houstoun** and A. S. **Russell.** The question is as to the effect of mixing two coloured solutions upon the absorption spectrum of each. Observations by Melde, Bostwick, Krüss, and Formánek seemed to indicate a shift of the absorption bands; but Schuster pointed out that a shift of this nature would be observed if, instead of mixing, the one solution was placed behind the other. Any other change indicated by theory would be too small to be appreciable. The experiments described in this paper were made by a differential method, so that the effect with the solutions in line, but not mixed, could be immediately compared with the effect when they were mixed. The conclusion come to was that there is no evidence for the existence of an effect of the kind described by the experimenters named above.

PARIS.

Academy of Sciences, November 2.—M. Émile Picard in the chair.—Spectroscopic researches on the Morehouse comet, 1908*c*: H. **Deslandres** and A. **Bernard.** The observations were commenced on October 14, ten days after those of La Baume-Pluvinel. Owing to the abnormal proportion of the blue to the ultra-violet rays, this comet, which was by eye observations of the sixth magnitude, appeared photographically of a higher magnitude. No trace of the hydrocarbon bands usual with comets could be detected; a continuous spectrum appeared on all the plates from October 14 onwards, but its intensity is relatively less than in the Daniel comet of last year. A table is given showing the wave-lengths and intensities of the principal condensations of the nucleus. Two ultra-violet bands of the cyanogen group are present, together with some lines of unknown origin, previously observed in Daniel's comet.—The pumice of the volcanic *massif* of Mont-Dore: A. **Lacroix.**—The value of the invariant ρ for a class of algebraic surfaces: L. **Remy.**—The influence of pressure on the ionisation produced in gases by the X-rays. The saturation current: E. **Rothé.** A study of the influence of pressure on ionisation phenomena in general. From pressures of 0·1 to 0·5 atmosphere the intensity of the saturation current is proportional to the pressure. The precautions found necessary for the regular working of the Crookes's tube are detailed.—Compensation electrometers and electroscopes: M. **Hurmuzescu.** The apparatus described, and of which a diagram is given, is capable of measuring potentials down to 0·01 volt.—An apparatus for receiving radio-telegraphic time signals on board ship: C. **Tissot** and Félix **Pellin.** A thermoelectric detector is employed, capable of responding to waves of one determined wave-length only.—A new determination of the mechanical equivalent of heat: V. **Crémieu** and L. **Rispail.** The heat produced was measured at constant temperature in a Bunsen ice calorimeter, the recent determinations of M. Leduc on the densities of the ice and water being used. The mean value obtained for J was $4{\cdot}1851\times10^7$ ergs, with an experimental error of less than 1/1500.—The separation of tungstic acid and silica: Paul **Nicolardot.** The method is based on the volatilisation of the tungsten by heating the mixture of tungstic acid and silica to 440° C. in a current of partially dried air and chloroform vapour.—The determination of the atomic weight of the simple ponderable substance, pantogen: G. D. **Hinrichs.** A fundamental material, pantogen, of atomic weight 1/128, or 0·007813, is assumed, and a theory developed of the weight and geometrical form of the atoms of hydrogen, helium, nitrogen, oxygen, and fluorine.—The phosphides of zinc: Pierre **Jolibois.** Zinc and red phosphorus were heated to a red heat in a crucible until phosphorus vapours ceased to be evolved. The resulting phosphide was separated from the excess of zinc by three methods:—the volatilisation of the zinc in a vacuum at 600° C., the solution of the zinc in mercury, and the action of fuming nitric acid. The same phosphide is left by all three methods of separation, and its composition corresponds to the formula Zn_3P_2. This phosphide with dilute hydrochloric acid gives a very pure phosphoretted hydrogen. The preparation and properties of ZnP_2 are also described.—The hydrolysis of perchloride of iron; the influence of neutral salts: G. **Malfitano** and L. **Michel.** Solutions of ferric chloride to which potassium chloride has been added present the phenomena of the colloidal state more rapidly and to a greater degree than solutions of pure ferric chloride. Other chlorides (sodium, barium, ammonium, magnesium) behave in a similar manner.—Aloesol, a complex phenol prepared with the aid of certain aloes: E. **Léger.** The tetrachloro-derivative of a new phenol is obtained by the action of hydrochloric acid and potassium chlorate on Cape aloes.—The fixation of different derivatives of the same colouring matter, and an explanation of dyeing: L. **Pelet-Jolivet** and N. **Andersen.** The experiments cited confirm the theory of dyeing of Freundlich and Loser.—Glycocholic acid: Maurice **Piettre.** The method described is capable of giving a yield of 60 per cent. to 75 per cent. of the bile as glycocholic acid, and the product is not contaminated with taurocholic acid, an advantage over the usual methods of separation. The chemical and physical properties of the purified acid are given, together with the results of some experiments on the toxic power of sodium glycocholate.—The colloidal properties of starch and the unity of its constitution: Eugène **Fouard.**—The oïdium of the oak: Paul **Hariot.** This disease of the oak has become widely distributed in France during the last year, and the dry north-east winds appear to have contributed to the spreading. All the native trees may be attacked, but the American oak appears to be immune.—The discovery of coal in Madagascar by Captain Colcanap: Marcellin **Boule.** Layers of coal, of a thickness of 0·3 to 0·5 metre, have been discovered in the neighbourhood of Bénénitra.—Report of the wireless telegraphy committee of the Academy of Sciences: Bouquet **de la Grye.**

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 12.

ROYAL SOCIETY, at 4.30.—The Charges on Ions in Gases, and the Effect of Water Vapour on the Motion of Negative Ions: Prof. J. S. Townsend, F.R.S.—The Charges on Ions produced by Radium: C. E. Haselfoot.—The Occlusion of the Residual Gas and the Fluorescence of the Glass Walls of Crookes's Tubes: A. A. Campbell Swinton.—An Investigation on the Anatomical Structure and Relationships of the Labyrinth in the Reptile, the Bird and the Mammal: Dr. A. A. Gray.—The Natural Mechanism for Evoking the Chemical Secretion of the Stomach (Preliminary Communication): Dr. J. S. Edkins and Miss M. Tweedy.—Further

Observations on Welwitschia: Prof. H. H. W. Pearson.—On the Presence of Hæmo agglutinins, Hæmo-opsonins and Hæmo-ly-ins in the Blood obtained from Infectious and Non-Infectious Diseases in Man (Preliminary Report): L. S. Dudgeon.—Preliminary Note on the Occurrence of a New Variety of Trypanosomiasis on the Island of Zanzibar: A. Edington.

MATHEMATICAL SOCIETY, at 5.30 (*Annual General Meeting*).—On the Theory of Groups of Finite Order (Presidential Address): Prof. W. Burnside.—On the Dirichlet Series and Asymptotic Expansion of Integral Functions of Zero Order: J. E. Littlewood.—The Norm Curves on a Given Base: Prof. F. Morley.—Satellite Curves on a Plane Cubic: J. O'Sullivan.—On the Arithmetical Nature of the Coefficients in a Group of Linear Substitutions (Third Paper): Prof. W. Burnside.—On the Second Mean Value Theorem of Integral Calculus: Dr. E. W. Hobson.—On the Representation of a Function by Means of a Series of Legendre's Functions: Dr. E. W. Hobson.—The Conformal Transformations of a Space of Four Dimensions and their Applications to Geometrical Optics: H. Bateman.—Periodic Properties of Partitions: D. M. Y. Sommerville.—The Solution of Integral Equations: Prof. A. C. Dixon.—The Eliminant of Three Quantics in Two Independent Variables: A. L. Dixon.—A Note on the Continuity or Discontinuity of a Function defined by an Infinite Product: G. H. Hardy.—The Energy and Momentum of an Ellipsoidal Electron: F. B. Pidduck.—On q-Integration: Rev. F. H. Jackson.—On q-Transformations of Power Series: Rev. F. H. Jackson.—The Complete Solution in Integers of the Eulerian Equation $X^4 + Y^4 = U^4 + V^4$: Dr. T. Stuart.—An Asymptotic Formula for the Generalised Hypergeometric Series: T. J. I'A. Bromwich.

FRIDAY, NOVEMBER 13.

PHYSICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.—Note on *Diplommatina strubelli*, Smith: E. A. Smith.—The Radulæ of British Helicids, Part ii: Rev. E. W. Bowell.—New Marine Mollusca from New Caledonia, &c.: G. B. Sowerby.—New Species of Macrochlamys and Monocondylæa from Siam: H. B. Preston.—A New Species of Oliva: F. G. Bridgman.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Huxley Memorial Lecture: The European Population of the United States: Prof. W. Z. Ripley.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Short-Period Variable W Ursæ Majoris: J. M. Baldwin.—On the Inclination of the Planes of some Spiral Nebulæ to the Galaxy: H. Knox Shaw.—Observations of Jupiter during the Apparition of 1907-8: Rev. T. E. R. Phillips.—Calendar Dates in the Aramaic Papyri from Assuan: J. K. Fotheringham.—On the Photographs of Comet 1908 *c* Morehouse: E. E. Barnard.—Observations of Minor Planets from Photographs taken with the 30-inch Reflector, 1907: Royal Observatory, Greenwich.—The Total Solar Eclipse of 1911, April 28: A. M. W. Downing.—The Comet of 1556; its Possible Breaking-up by an Unknown Planet into Three Parts, seen in 1843, 1880, and 1882: Prof. George Forbes.—On the Old Observations of Jupiter's Satellites: Prof. R. A. Sampson.—An Improved Telescope Triple Object Glass: J. W. Gifford.—Real Paths of Brilliant Meteors Observed in 1908: W. F. Denning.—(1) Photographs of Comet *c* 1908; (2) Note on the Telegraphic Determination of the Longitude Greenwich-Ascension-Cape, in the Year 1908; (3) Note on the Appearance of Saturn's Rings, 1908 October: Royal Observatory, Greenwich.—Note on the Regnal Years in the Aramaic Papyri from Assuan: E. B. Knobel.—(1) Historical Data for the Secular Acceleration of the Moon: (2) Oppolzer's and Ginzel's Corrections to Hansen: J. K. Fotheringham.—*Probable Papers:* On the Absorption of Light in its Passage through Interstellar Space: (2) Note on the Number of Faint Stars with Large Proper Motions: Prof. H. H. Turner.—The Flagstaff Photographs of Mars in 1907: E. M. Antoniadi.—Illustrations of Recent Work on Solar Vortices: Prof. G. E. Hale.

MONDAY, NOVEMBER 16.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Some Aspects of the River Paraná, and its Watershed: an Economic Survey: W. S. Barclay.

TUESDAY, NOVEMBER 17.

ZOOLOGICAL SOCIETY, at 8.30.

ROYAL STATISTICAL SOCIETY, at 5.

MINERALOGICAL SOCIETY, at 8.—On a New Method for Studying the Optical Properties of Crystals: the late Dr. H. C. Sorby, F.R.S.—Note on the Spontaneous Cry-tallisation of Drops of Solutions in Spherulites: M. Jacques Chevalier.—On the Composition of the Chandakapur Meteoric Stone: H. E. Clarke and H. L. Bowman.—On Micas from North Wales and Connemara: Dr. A. Hutchinson and W. Campbell Smith.—On the Occurrence of a Rare Mineral, Carminite in Cornwall: Arthur Russell.—On Russian Universal Instruments and Methods: T. V. Barker.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* Glasgow Central Station Extension: D. A. Matheson.

WEDNESDAY, NOVEMBER 18.

ROYAL SOCIETY OF ARTS, at 8.—Inaugural Address by Sir William White, K.C.B., F.R.S.

GEOLOGICAL SOCIETY, at 8.—The Geological Interpretation of the Earth-Movements Associated with the Californian Earthquake of April 18, 1906: R. D. Oldham.—On some Intrusive Rocks in the Neighbourhood of Eskdale, Cumberland: A. R. Dwerryhouse.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—The Present Status of Micrometry: Dr. Marshall D. Ewell.—Note on a New Growing Cell for Critical Observation under the Highest Powers: A. A. C. E. Merlin.—Studeria, a Remarkable New Genus of Alcyonarians: Prof. J. A. Thomson.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Twenty-fifth Anniversary of the German Meteorological Society held at Hamburg, September 28–30, 1908: Henry Harries.—Investigation of the Electrical State of the Upper Atmosphere made at the Howard Estate Observatory, Glossop: W. Makower, Margaret White and E. Marsden.—Balloon Observations made at Birdhill, Co. Limerick, during July and August, 1908: Capt. C. H. Ley.

THURSDAY, NOVEMBER 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Memoir on the Theory of the Partitions of Numbers. Part IV.: On the Probability that the Successful Candidate at an Election by Ballot may Never at any Time have Fewer Votes than the One who is Unsuccessful; on a Generalisation of this Question; and on its Connection with other Questions of Partition, Permutation, and Combination: Major P. A. MacMahon, F.R.S.—The Propagation of Groups of Waves in Dispersive Media, with Application to Waves on Water produced by a Travelling Disturbance: T. H. Havelock.—On the Refraction and Dispersion of Krypton and Xenon and their Relation to those of Helium and Argon: C. Cuthbertson and M. Cuthbertson.—Note on Horizontal Receivers and Transmitters in Wireless Telegraphy: Prof. H. M. Macdonald, F.R.S.—On Optical Dispersion Formulæ: R. C. Maclaurin.—(1) On the Accumulation of Helium in Geological Time: (2) On Helium in Saline Minerals and its Probable Connection with Potassium: Hon. R. J. Strutt, F.R.S.—Note on the Effect of Hydrogen on the Discharge of Negative Electricity from Hot Platinum: Prof. H. A. Wilson, F.R.S.—On Measurement of Rotatory Dispersive Power in the Visible and Ultra-violet Regions of the Spectrum: Dr. T. Martin Lowry.

CHEMICAL SOCIETY, at 8.30.

LINNEAN SOCIETY, at 8.—On a New Species, Symphyla, from the Himalayas: Prof. A. D. Imms.—The Freshwater Crustacea of Tasmania, with Remarks on their Geographical Distribution: Geoffrey Smith.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Inaugural Address by the President: Mr. W. M. Mordey.

FRIDAY, NOVEMBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Resistance of Materials to Impact: Dr. T. E. Stanton and L. Bairstow.—Different Methods of Impact Testing on Notched Bars: F. W. Harbord.

CONTENTS.