THURSDAY, FEBRUARY 16, 1905.

THE HISTORY OF COAL MINING.

Annals of Coal Mining and the Coal Trade. Second Series. By R. L. Galloway. Pp. xvi+409. (London: Colliery Guardian Co., Ltd., 1904.)

IN a former volume (noticed in NATURE, vol. lix. p. 337) the author carried his annals of coal mining down to the period of the Select Committee of the House of Commons on Accidents in Mines in 1834. He now continues the subject to the passing of the Coal Mines Inspection Act of 1850, and to the establishment of the Royal School of Mines. This volume, like its predecessor, is comprehensive and accurate, and a monument of industry and of thorough technical knowledge.

The period of fifteen years reviewed is one of much interest. After ten years of stagnation came a remarkable increase of activity in the coal and iron industries. The chief causes that imparted the impetus were the rapid extension of steam navigation and the mania for constructing railways. Fresh life had been given to the manufacture of iron by the introduction of hot blast, and, owing to its increasing cheapness, the metal was being more largely used in collieries. Steel, however, was still a scarce commodity. The chief seat of mining operations at this period was in the Wear and South Durham district. In South Wales a considerable development of the steam-coal district took place, owing largely to the opening of the West Bute Dock at Cardiff in 1839. In Yorkshire the greatest depth attained in 1841 was at Barnsley, where the coal lay 594 feet below the surface. In Lancashire two pits were begun in 1838 at Pendleton, which reached the coal at 1392 feet, whilst at Apedale, in North Staffordshire, there was a mine with the exceptional depth of 2177 feet. Frequent instances of spontaneous issues of fire-damp are recorded. Full details of the various explosions are given by the author, and the gradual improvements in mining operations are traced. The author's records show that the men who did most to advance mining progress at this period were John Buddle, of Wallsend (1773–1843), Dr. W. R. Clanny (1776–1850), Sir Henry De la Beche (1796–1855), Michael Faraday (1791–1867), Sir Goldsworthy Gurney (1793–1875), Lord Playfair (1818–1898), Sir Warington Smyth (1817–1890), and James Young, of Bathgate (1811–1883), the founder of the Scotch mineral oil industry.

Incidentally, Mr. Galloway gives interesting etymological details of some local terms the origin of which is uncertain. Thus, in South Staffordshire and Scotland the word "butty" signifies a comrade or associate. Assuming neighbourhood to have been the original idea, a root for the word is suggested by the author in the term "but" as used in the expression "but and ben," applied to a divided house shared by two occupants. Again, what appear to be traces of a primitive state of servitude existed in Staffordshire, where the labourers employed in the haulage of coal continued to be known as "bondsmen"—a name probably coming down from a remote period; a supposition which receives support from a peculiar service required of them, known as "buildases." This consisted in working at times in the morning without receiving any payment beyond a drink of ale. This custom of exacting labour without pay is supposed to represent some ancient service required from their tenants by the monks of the Abbey of Buildwas, in Shropshire, whence the name was derived. Another etymology would have buildas, a contraction of build-house, because the money obtained by means of this unpaid labour enabled the butties to build rows of cottages. Another curious term was that applied to the small stools which in the north of England formed a regular part of the collier's accoutrements. This stool was known as a "cracket," a word which appears to be a variety of cricket.

In reviewing the history of this interesting period it is surprising to find what a large number of recent inventions had been anticipated. For example, the pneumatic system of haulage, successfully applied by Blanchet at Epinac, in France, in 1877, was patented in 1845 by Knowles and Woodcock in Lancashire. The use of reciprocating rods to raise vessels containing coal adopted on the Continent by Méhu, and subsequently by Guibal, was made the subject of a patent by Slade in 1836. The process of raising mineral in successive stages, proposed for working the deep-level mines of the Witwatersrand, appears to have been not uncommon during the first half of the nineteenth century. Winding by endless chain, as proposed by O. C. von Verbo in a book published a few months ago, was patented as early as 1789; and in 1839 an automatic arrangement for cutting off the steam and applying the brake, invented by John Wild, was in operation in Lancashire. The well known ventilator patented by W. P. Struvé was identical in principle with the hydraulic air-pump used in the Hartz mines since the Middle Ages. Iron props, adopted in France in 1880, were used in Derbyshire collieries in 1811, as were also pieces of timber built up two and two crosswise so as to form a square pillar. This so-called pig-sty timbering was introduced as a novelty by the Australian miners at the Day Dawn mine, in Queensland, ten years ago.

In one respect the work is open to criticism. The title "Annals of Coal Mining" should more properly have been "Annals of British Coal Mining," inasmuch as Continental and American practice is barely mentioned. This is to be regretted, as during the period under review several events happened abroad to which reference might usefully have been made. Thus, the first Belgian railway was opened in May, 1835, the first German railway in December, 1835, the first French railway in 1837, and the first Austrian railway in 1838. The first railways made in the United States were coal roads to the mines. In 1835 Thomas and Laurens suggested heating boilers with blast-furnace gas. In 1835 Kind improved the methods of deep boring. In 1846 Schönbein discovered gun cotton, and nitroglycerin was invented in the following year. In 1830 the modern mine-theodolite was invented by F. W. Breithaupt, of Cassel, and in 1845, in France,

the trust-like company of the Loire was formed, that was the prototype of the coal trusts and syndicates of to-day. Events such as these had a far-reaching influence on the development of the coal-mining industry.

Special commendation is due to the author for the scrupulous accuracy with which references to original authorities are given, and for the care with which the proof-sheets have been read. Two trifling misprints have, however, escaped detection. Freiberg appears as "Freyburg" (p. 292), and Sir Marc Isambard Brunel as "M. J. Brunel" (p. 291).

BENNETT H. BROUGH.

MATHEMATICS OF BILLIARDS.

Billiards Mathematically Treated. By G. W. Hemming, K.C. Second edition. Pp. 61. (London: Macmillan and Co., Ltd., 1904.) Price 3*s.* 6*d.* net.

MORE fortunate, or more careful, than most authors, Mr. Hemming, whose recent death will be regretted by many, did not find it necessary in his second edition to make any material alterations in his original work. He added two appendices, iii. and iv., with which alone it is necessary to deal in the present notice.

Appendix iii. discusses the comparative advantages of fine and through strokes, with regard to the margin of error permissible in the respective cases. In the figure opposite p. 47, A is the player's ball, O the object ball, and the stroke is to make A, after striking O, pass within a distance of the point P depending on the nature of the stroke, namely, for a cannon a distance equal to the diameter of a ball, for a losing hazard the necessary distance from the centre of the pocket, which may vary between different tables. The angle AOP is given by the conditions of the problem, and in the notation adopted is $\pi-\Delta$. The angle of aim, OAS, is the thing to be determined. It shall be denoted by α, as in appendix ii. of the first edition. In the present appendix A_1 is also used for the same angle. S denotes the position of the centre of the striking ball at impact, SO being the common normal. If $ASO=\pi-\theta$, θ and α are connected by the relation $\sin\theta/\sin\alpha=AO/OS=AO/2$ if we denote OS, the diameter of a ball, by 2; and in the special case considered of $AO=PO=30$, or 15 diameters, we might to a very near approximation use α instead of $\sin\alpha$. Further, the angle OPS is denoted by P_1, and the angle of deviation, $\pi-ASP$, by δ. It is then shown that as the equation connecting δ and θ,

$$\tan(\theta+\delta)=p\tan\theta,$$

where, for reasons given in the former edition, $p=3{\cdot}5$. From this last equation δ may be obtained in terms of θ or α. In fact,

$$\tan\delta=(p-1)\sin\theta\cos\theta/(\cos^2\theta+p\sin^2\theta)$$

is easily found.

The complete method, were it practicable, would be to find an equation in θ or α having two roots, one of which, say θ_1, should correspond to the fine, the other, θ_2, to the through, stroke, and thence the margin of error might be found for each stroke. This analysis being difficult, a practical solution is obtained by means of a diagram in which the ordinate y represents $\sin\Delta$, given by the conditions, and the abscissa x represents $\sin\theta$ in an actual stroke in which, for given Δ, the ball A passes over or very near to P. A series of values of $\sin\theta$ being found corresponding to a series of values of $\sin\Delta$, we draw a freehand curve through them. In general, a line parallel to x for given y cuts this curve in two points, namely, P_y, in which θ has the smaller value (the through stroke), and Q_y, in which it has the greater value (the fine stroke). It comes next in order to find for any y the margin of error for P_y and for Q_y. This is done by using the formula of appendix ii., first edition. The linear error on the object ball is (AO being 30) $30\delta\alpha$. The consequent linear error at P ($PO=30$) is denoted by E. Then $30\delta\alpha/E$ gives the margin of error. A new curve, called the blue curve, is then drawn, having for abscissa $x=\sin\theta$, and for ordinate $y=30\delta\alpha/E$, in the same way, by a series of trials, as the first curve. The blue curve has two branches. Then the margin of error for any of the points P_y or Q_y of the first curve is that ordinate of the blue curve which has the same abscissa. As the result of this method it is found that the margin of error is the same for the through as for the fine stroke, when $\sin\Delta=0{\cdot}320$, and $\sin\theta=0{\cdot}132$ for the through, and $\sin\theta=0{\cdot}960$ for the fine stroke. For smaller values of Δ the through stroke has the advantage; for larger values of Δ the fine stroke, until a certain maximum is reached.

In appendix iv., f, the coefficient of friction between two balls at impact, formerly taken as zero, is assumed to have the values 0·01 or 0·02, and it is found that, instead of $p=3{\cdot}5$, as above assumed, we should have

$$\text{for } f=0{\cdot}01\quad p'=3{\cdot}445+0{\cdot}0625\cos\theta$$
$$\text{for } f=0{\cdot}02\quad p'=3{\cdot}391+0{\cdot}125\cos\theta.$$

It will be observed that both these values of p' give very approximately $p'=3{\cdot}5$ when $\theta=30°$, that is, for the half-ball stroke.

Before this notice was in type Mr. Hemming was taken from us by death, to the sincere regret of his many friends, including the present writer.

S. H. BURBURY.

A MORPHOLOGY OF THE ALGÆ.

Morphologie und Biologie der Algen. By Dr. Friedrich Oltmanns. Vol. i. Special part. Pp. vi+733; illustrated. (Jena: Gustav Fischer, 1904.)

THE charming little university town of Freiburg has been the birthplace of important ideas in an obscure department of natural history. De Bary began there his researches into the life-history of the lower fungi, and afterwards continued them at Halle and Strassburg. Owing to his great work and inspiration we botanists owe a germ-theory of disease—a theory which was in time to bear fruit in practical, medical and surgical form in the mighty hands of Lord Lister. To Freiburg, then, we come again for a morphology of the kindred group of the Algæ.

There is a difficulty in understanding how even an assiduous German professor, living so remote from the sea as Freiburg is, can have obtained the inspiration which has guided his research for years past. The

study of organisms, which in a living state are for the most part many hundreds of miles from his door, must have presented a task in conquering which his zeal and power of work can find no better example than the volume before us. To a great extent this work must have been book work, and excellent book work it is, the purely bibliographical work especially; and with the aid of herbarium specimens Dr. Oltmanns has succeeded in giving us a general morphology of the Algæ—a treatise to have been expected only from one with abundant leisure and a microscope near the sea. To approach, then, in a spirit of criticism an encyclopædic book of this kind, to try to gauge its worth, seems in the circumstances scarcely "sportsmanlike," if I may use such a term, on the part of one who has had so many greater opportunities of observation.

The De Bary of the subject is, of course, Dr. Bornet, and no student can for a moment question his pre-eminent claims to instruct us. Schmitz, of Greifswald, whose loss we can never cease to deplore, seemed destined to employ his indomitable industry in a work of this kind. Happily we have Dr. Oltmanns, and happily he has had the courage to undertake a task so full of use and pleasure to all students of this fascinating group of plants.

I do not wish for a moment even to seem to detract from the great performance of Dr. Oltmanns. One irresistibly comes back to the Freiburg and De Bary standard. One hoped for a general morphology of the Algæ as De Bary gave us one of the fungi. Dr. Oltmanns has given us an encyclopædic book—an admirable one—but not the reasoned work of genius botanists have dreamt of.

According to personal prejudice, very possibly, I mean prejudice in the right sense of the word, I turned first to the obscure groups of primitive Algæ, groups that I have had so many opportunities of studying on the sea, and of which Dr. Oltmanns can have had few chances of seeing living specimens. It so happened that while writing this review the present writer was engaged in describing a new generic form of pelagic Alga obtained on the outward voyage of the *Discovery*. The point was put to the test by consulting Dr. Oltmanns's descriptions and bibliography. From that, of course, the original sources were taken and verified, not so much for the immediate purpose, as was natural in any case, as for the aim of doing justice in reviewing Dr. Oltmanns's book. The result was triumphant for Dr. Oltmanns—every reference and every description having been pursued to its original source. It is difficult to establish a negative, but no reference was found wanting.

Naturally one turned next to the group Dr. Oltmanns has made his own—the Fucaceæ. It may seem presumption, but it was dutiful, and here, again, the book stood every test. The other groups of Algæ were not made the subject of such rigorous treatment, but they were examined with scrutiny enough to warrant the expression of a very warm and hearty recommendation of this great book to the consideration of botanists and cultivated readers.

GEORGE MURRAY.

OUR BOOK SHELF.

Game, Shore and Water Birds of India: with Additional References to their Allied Species in Other Parts of the World. By Colonel A. Le Messurier, C.I.E., F.Z.S., F.G.S. Fourth edition. Pp. xvi+323. (London: Thacker and Co., 1904.)

THE first edition of this work was a modest little volume, printed for private circulation only, on the birds of Sind. This appeared so far back as 1874. Four years later, with some additions, it was issued to the public. Hume and Marshall's epoch-making work on the game birds of India appearing at the same time made a third edition imperative. This in due time appeared, and large additions were made thereto, taken, with acknowledgments, from this formidable rival. Meeting with a well merited success, a fourth edition has now been issued, which differs from the earlier volumes in that it "includes references to all species in other parts of the world that are allied to the Game, Shore, and Water Birds of India."

This addition is made on the curious plea that "owing to the facilities of travel, Anglo-Indians are now engaged in most countries either on business or pleasure." It is to be supposed that Anglo-Indian sportsmen are here specially referred to, and further, that, save for this volume, no information concerning the avifauna of the countries they propose to visit is obtainable. That this is not the case it is needless to say, and the traveller-sportsman would be ill advised who started on his journey with this volume for his only guide and counsellor.

In so far as it concerns the birds of India likely to interest the sportsman, this book will do very well; but it would have been vastly improved if the space now devoted to extra-Indian birds had been utilised for fuller descriptions of the native species, and for the description of the geographical and climatic conditions of the several regions of this vast hunting ground.

The introduction to this book contains, we venture to think, not a little that is out of place in a work of this kind. Much of it is admittedly compiled from abstruse scientific treatises, or from the labels of the Natural History Museum at South Kensington.

There can be no doubt but that the author, during his long residence in India and his wide experience in the field, must have accumulated a vast store of facts concerning Indian birds which would be well worth recording. For this reason, therefore, we regret that he decided on including in this edition matter really foreign to the scope of his book. His first-hand observations would have been of infinitely more interest and value than the compilation now presented.

The illustrations are numerous, and mostly very crude. W. P. P.

The Species of Dalbergia of South-Eastern Asia. By Dr. D. Prain. (Annals of the Royal Botanic Gardens, Calcutta, vol. x., part i.) Pp. iv+114; and plates. (Calcutta, 1904.) Price 1*l.* 13*s.*

THE stages in the evolution of the genus Dalbergia are sketched in the early pages of this memoir. After removal of the extraneous species, the genus was delimited by Bentham in 1851, and four subdivisions, Selenolobium, Dalbergaria, Sissoa, and Triptolomea, were mapped out. Although Bentham himself pointed out that there was overlapping in these subdivisions, the grouping has been maintained by later systematists down to and including Taubert, who undertook the Leguminosæ for the "Pflanzenfamilien" in 1894. Dr. Prain, who had previously reviewed the genus when collating the Leguminosæ in connection with "Materials for a Flora of the

Malayan Peninsula," has, after a study of several years, introduced a new arrangement with two main sections, Sissoa, which includes the greater part of Bentham's Triptolomea and Sissoa, and Amerimnon, called after an American type. Dr. Prain's classification differs from Bentham's, since he adopts the shape and orientation of the corolla and the form of the style as the criteria of his subdivisions instead of the characters of the inflorescence, stamens, and fruit.

The genus is distributed through the tropics of Africa and America as well as Asia, and it seems a pity that the author did not see his way to extend his monograph to all the known species. The distribution in Asia is considered for five provinces, East China, Indo-China, Indo-Himalaya, Malaya, and Papuasia; the number of endemic species in each is large, and amounts to 72 per cent. for East China. Very few species are found in more than two of these provinces; *Dalbergia tamarindifolia* occurs in four, and *Dalbergia torta* (=*D. monosperma*), which has pods well suited for dispersal by ocean currents, is the only species found in all five provinces. Owing to the inclusion of recent specimens from Malay and China, the total number of authenticated species amounts to eighty-six; a few, including the *Dalbergia laccifera* of Lanessan, still remain unidentified. The memoir is illustrated with diagrams of groupings and maps of distribution, as well as with figures of each species, and issued as the first part of the tenth volume it forms a valuable addition to the *Annals* of the Royal Botanic Gardens, Calcutta.

The Process Year Book. Penrose's Pictorial Annual, 1904–5. Edited by William Gamble. Pp. xvi+160. (London: Penrose and Co.)

EVERY year we receive this annual, and each time it is our pleasure to point out the very high standard which the volume attains. The current issue bids us to repeat the opinions expressed in our previous notices, and to supplement them with the statement that the standard has again been changed to one of a higher order.

To gain some idea of the possibilities of process work of to-day, when the best work and materials are employed, the reader has only to take up this book and examine the contents, which will at once indicate the high state of efficiency and the variety of methods that are available. In the first place we have a series of instructive articles, covering 160 pages, most of which are from the pens of well-known workers. These deal with manifold portions of a far-reaching subject, and give the advice, results of experience, and views of these workers on numerous points of interest. Of the illustrations, which form such a conspicuous feature of this annual, much could be written, for it is in them that we see the practical results of the processes in use to-day. If we sum up the plates, colour prints, supplement illustrations, and illustrations in the text, we have a collection which for variety of subjects and excellence of reproduction is unique. The photogravure, as a frontispiece by J. J. Waddington, Ltd., the "Turner" reproduced by the three-colour process of André and Sleigh, and the interlayed half-tone by the Arthur Cox Illustrating Co., Ltd., are three amongst a host of other good samples that are met with.

Apart from the large number of process workers who await annually the appearance of this year book, this handsome volume will appeal to a wide circle of readers who are in any way connected with the artistic or utilitarian side of the art of reproducing pictures. The editor and his contributors, together with the publishers and printers, all deserve great credit for such an admirable result of their combined efforts.

LETTERS TO THE EDITOR.

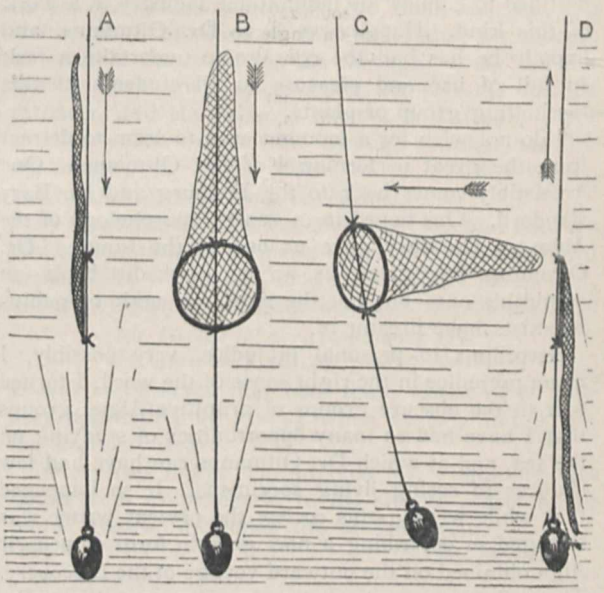
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On a Method of Using the Tow-net as an Opening and Closing Tow-net.

EVERY naturalist who has engaged in marine research is aware of the great difficulties which attend upon research in the intermediate depths.

Great ingenuity has been displayed in the invention of very elaborate instruments—many of them hopeful, some of them successful. It had appeared to me, as the result of observations, and after conversation with Mr. J. Y. Buchanan, who had made similar observations, that a solution of this problem might be found easily in experiments with the ordinary tow-net.

Our joint experience was this. If an ordinary tow-net were lashed at two opposite points of the rim to a rigid sounding-wire, and so plunged at speed into the depths, the net would fold over and close. It might then be towed at the required depth and afterwards reeled in by the sounding engine at express speed—again closing in its upward course.



Through the great kindness and sympathy of Mr. M. H. Gray, of the Silvertown Submarine Telegraph Company, I was afforded an opportunity of putting this theory to the test on board the *Dacia*.

The conditions of the experiment appeared to me at the time adverse, since my tow-nets and other apparatus were missing at Gibraltar; but this was a blessing in disguise. I set to work and made a tow-net out of old bunting and the rim out of a barrel hoop. This tow-net was so flimsy that in towing it alongside at little more than mere steerage-way it frequently burst. To plunge it into the depths would be a supreme test, since not even No. 20 Miller's Silk in an open net could stand the strain I proposed. Off the north-west coast of Africa I had three days' opportunity of experiments, the absurd tow-net being in ludicrous inverse proportion to the magnificent sounding crew and sounding engine. A reference to the diagram will show A, the descent of the net folded over; B, the net opening at the required depth; C, the net being towed at the required depth; and D, the net being reeled in closed as in its descent.

I confess that when the first experiment was made I had faint hope of seeing that flimsy tow-net again, but it emerged with many organisms we had not captured on the surface. To cut matters short, these experiments were

repeated for three days without a hitch at from 200 to 300 fathoms, the flimsy net emerging from its trials on every occasion with success.

There are two practical points. The first is the art of plunging the net at the surface, the next that of whipping it out on reeling in, so that there may be no contamination of surface organisms during the critical moments. With a highly expert sounding crew such as I had at my service this was easily done.

My repeated experiments were also addressed to this point, viz. to ascertain the best rate of descent and ascent of the net, and my experience was 100 fathoms a minute. The flimsy net stood all tests.

To the modern marine naturalist, whose complicated (and expensive) opening and closing tow-net is an object of worship, this simple advice may seem like telling him to "bathe seven times in Jordan"; he wishes to do a great thing. GEORGE MURRAY.

February 5.

The Sixth Satellite of Jupiter.

THE author of the article on the sixth satellite of Jupiter in NATURE of January 19 has obviously made a slip in assuming that the "retrograde" motion ascribed to the satellite means retrograde in the sky, and not in the orbit. According to the ephemeris, Jupiter on January 4 was moving direct, *i.e. eastward*, about 225″ daily. The satellite was *west* of the planet (position angle 269°), approaching Jupiter at the rate of 45″ a day, and, therefore, moving eastward (direct) about 270″ daily.

The position angle on January 17, according to the latest bulletin from Mount Hamilton, was 266°, having decreased 3°; the distance of the satellite had decreased from 45′ to 36′. If the object is really a satellite this necessarily indicates a retrograde orbital motion, unless the plane of its orbit is so much inclined to that of the other satellite-orbits as to make the new one pass north of the planet at inferior conjunction instead of south as the others now do.

The observations thus far published would, however, apply equally well to an asteroid a little within or beyond the orbit of Jupiter, and near perihelion in an orbit of some eccentricity and with a mean distance from the sun somewhat greater than that of Jupiter. We must wait for further observations to determine the truth. C. A. YOUNG.

Princeton, N.J., U.S.A., February 3.

The Circulation of the Atmosphere.

I HAVE read with great interest your review of Prof. H. H. Hildebrandsson's report on "The General Motion of Clouds" (NATURE, February 2, p. 329).

All his observations appear to support the theory of my father, the late Prof. James Thomson, as set forth in the Bakerian lecture on "The Grand Currents of Atmospheric Circulation" (*Phil. Trans.*, vol. clxxxiii. p. 653, 1892) and in his earlier paper read before the British Association in 1857.

Is it possible that Prof. Hildebrandsson has not seen these papers, and has accepted theories put forward as Prof. James Thomson's instead of referring to the originals? Anyone who takes the trouble to read these papers carefully must see that it is distinctly stated that the main direction of the upper current of the atmosphere is from west to east while moving steadily and gradually towards the Poles, and that the air keeps this west to east motion as it sinks to a lower level, and becomes the great return current towards the equator. This motion can hardly be termed "vertical circulation." As for Prof. Hildebrandsson's assumption concerning Hadley's theory, I should like to quote the following passage from my father's paper:—

"In 1735 George Hadley submitted to the Royal Society the paper of which I have made mention already as supplying for the first time a substantially true theory of the primarily dominant conditions of atmospheric circulation. The paper is entitled 'Concerning the Cause of the General Trade Winds,' and it is right here to notice that Hadley applied the name 'General Trade Winds' not merely to those winds of equatorial regions to which the name Trade Winds is ordinarily restricted, but uses it as including also the west to east winds known to be prevalent in higher latitudes, and used in trade by mariners for ocean passages from west to east. Thus the scope of his theory must be understood as being much wider than what would be conveyed in ordinary nomenclature by the name Theory of the Trade Winds."

So far then from opposing Hadley's theory, my father's amplifies and completes it. JAMES THOMSON.

22 Wentworth Place, Newcastle-on-Tyne, February 6.

Remarkable Temperature Inversion and the Recent High Barometer.

DURING Friday and Saturday, January 27 and 28, the barometric pressure over the south of England was exceptionally high, readings of 31.00 inches being observed at 6 p.m. on Saturday in the extreme south-west of the country. In the neighbourhood of London the barometer rose to 30·90 during the night of January 26, and remained at about that height until the morning of January 29, a well marked anti-cyclone with readings over this value being shown on

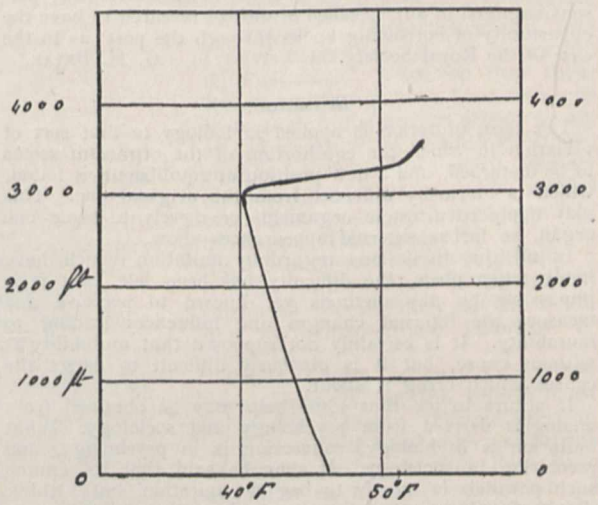


FIG. 1.—Temperature inversion on January 28 at Oxshott, Surrey.

the morning and evening weather charts of January 27 and 28.

During such conditions it is in general impossible to raise a kite, owing to the want or lightness of wind; but on January 28, during the afternoon, there was sufficient breeze from the west to start a kite carrying recording instruments, and to take them to a height of 3600 feet. A very remarkable temperature inversion was found to exist, the details of which are shown in the accompanying chart. At 3.40 p.m. the surface temperature was 47°·0 F.; at 4.45 p.m. it had fallen to 45°·0 F. The temperature decreased steadily to 40° F. at 3000 feet; a little higher a rise of 12° took place, the temperature at 3300 feet being 52° F. At 4.28 p.m., at 3600 feet, the temperature was 53° F. Unfortunately, the humidity trace on the meteorograph partially failed, but it suffices to show that the temperature inversion was, as such inversions in my experience always are, accompanied by extreme dryness of the air.

The wind was west at the surface, and shifted gradually to north-west at the highest point reached, but there was no sudden change of direction at the height where the temperature inversion occurred.

I do not wish to imply that the high barometer and the temperature inversion are necessarily correlated phenomena, but the coincidence is interesting. W. H. DINES.

Dates of Publication of Scientific Books.

WITH reference to the complaint of Mr. R. P. Paraiypye (p. 320) that a big sum is still asked for Price's "Treatise on Infinitesimal Calculus," I should be obliged if you would allow me to point out that the price of this work is, and has been for some time, 5*s.* a volume.

HENRY FROWDE.

Oxford University Press Warehouse, Amen Corner, London, E.C., February 8.

A National University Library.

IT must be the experience of any graduate of Oxford or Cambridge who is residing at a distance from those university towns that a serious obstacle to the prosecution of research arises from the impossibility of consulting the university libraries, and the absence of any provision for borrowing volumes, or obtaining references under arrangements similar to those pertaining at the libraries of the Royal and other scientific societies. Moreover, while Oxford and Cambridge possess the special privilege of acquiring free copies of books copyrighted in England, there are now many universities in this country which are far too poor to keep up even a decently respectable library in any branch of science.

The conditions of modern times have created a need for a National University Library, enjoying the same privileges as the Oxford and Cambridge libraries, and which should be available for graduates of any British university; persons engaged in any specified branch of research to have the opportunity of borrowing books through the post as in the case of the Royal Society. G. H. BRYAN.

Mutation.

THE term mutation is applied in biology to that sort of variation in which the equilibrium of the organism seems to be disturbed, and a new position of equilibrium is found, which is markedly different from the original one. This may apply to a whole organism or merely to some one organ, so far as external appearances show.

In all the discussions regarding mutation which have lately taken place, the difficulty has been felt that it is impossible by any methods yet known to perceive and measure the internal changes and influences leading to mutability. It is certainly not supposed that mutability is without cause, but it is obviously difficult to detect the causes which bring it about.

It occurs to me that some help may be obtained from analogies derived from psychology and sociology. What mutation is in biology, conversion is in psychology, and revolution in sociology. It may be said that to assume such parallels is merely to beg the question, but I think that the apparent parallelism cannot be without significance. Now the phenomena leading towards conversion have been studied subjectively (*cf.* James, "Varieties of Religious Experience"), and those leading towards revolution have been studied objectively, with certain well-defined results. If the supposed analogy is a valid one, it appears to follow that mutability is due to the same general causes as ordinary variability (just as change of opinion and reform are due to the same general causes as conversion and revolution), but that there is this difference—mutability represents an explosion of energy, as it were, in a given direction, and therefore differs from ordinary variation somewhat as the firing of a gun differs from the explosion of a loose heap of powder. It also follows that the cause of the explosion is not plasticity in the organism, but in some measure the reverse; that is, the power of being influenced, and at the same time of withstanding the expression of the influence until it had acquired considerable force. This implies a certain rigidity of type, quite comparable with a type of mind familiar to all. It further appears to follow that the chance of mutations succeeding from the first is comparatively remote, though such a thing is quite possible; but since they are the result of general causes, the sort of changes the mutations exhibit are likely to come about in due course, just as the sort of changes represented by a revolution are likely to prevail ultimately, though the revolution itself may appear to fail.

T. D. A. COCKERELL.

University of Colorado, Boulder, Colorado, January 25.

Fact in Sociology.

MR. WELLS is a dangerous man to criticise. Such thunderbolts as "crude," "dull," "balderdash," come hurtling at one's head even from his modified letters (NATURE, February 2). But I prefer to regard it all as meant only for sheet lightning. Indeed, when I consider the courtesy that characterised my article (NATURE, December 29), plain-spoken though it was on some points, I cannot take any other view.

Now to Mr. Wells's points in order.

(1) "'The Food of the Gods' does not claim to forecast the future." My mistake was natural. It only shows the risk Mr. Wells runs in appearing before the world in two entirely different characters. Still, I hit upon a weak point. He pictures an ideal State, but cannot show us how it is to be realised. Archimedes had no fulcrum for the lever with which he would have moved the world. Mr. Wells has no power to apply to his.

(2) "*I have mixed up 'Anticipations'* and *'Mankind in the Making.'*" Why keep them separate? "Anticipations" also deals largely with ideals.

(3) *Re* the question—Which of the great national "syntheses" will attain predominance, see "Anticipations," chap. viii. *passim*, and especially pp. 100, 101 (6*d.* ed., 1904). This chapter seemed to me an interesting speculation, but Mr. Wells describes what I thought, and, on re-reading, think is to be found in it as "balderdash." True, through inadvertence I wrote "Anglo-Saxon" instead of "English-speaking," for which I am sorry.

(4) *Re* the recruiting of the upper strata of society from the lower, nothing, he says, is known about this. Still, those who have studied human evolution think they know something. Prof. Karl Pearson even says that there are "class statistics" for the population of Copenhagen, and writes, "the population would accordingly appear to be ultimately, and in the long run, reproducing itself from the artisan classes" (*Natural Science*, May, 1896). Dr. Mercier (see the Sociological Society's papers, 1904, p. 55) regards "a civilised community in the light of a lamp, which burns away at the top and is replenished at the bottom." As to "stagnant" classes, I find in "Anticipations," p. 121, "It (the new Republic) will tolerate no dark corners where the people of the Abyss may fester, no vast diffused slums of peasant proprietors, no stagnant plague preserves." See especially p. 117 for Mr. Wells's plan for getting rid of undesirable types. As to careful parentage, see "Mankind in the Making," p. 99:—"The first step to ensuring them (the ends aimed at) is certainly to do all we can to discourage reckless parentage."

In conclusion, let me describe myself as a much-battered but not unfriendly critic of the New Republic.

F. W. H.

The Melting of Floating Ice.

MAY I suggest that Dr. Deventer, of Amsterdam, whose letter to you is referred to in your issue of January 26 (p. 303), has discovered a "mare's nest"?

His observant pupil, who noticed that in a glass filled to the brim with water and floating ice the melting of the latter did not cause overflow, was apparently totally ignorant of the laws of flotation, or he would not have expected otherwise. Why should the level of the water change? The ice in melting must of necessity just fill with water the space that it displaced when floating, and so the level remains unaltered. So Dr. Deventer's statement that "when a vessel contains a solid floating in its own liquid, the level of the latter does not change by the melting of the solid" appears quite superfluous.

As to making this a "general" law applying to *solids floating in their own liquids*, surely the rule is that solids do *not* do so, but sink. Why make a general law which only applies in the case of a very few exceptional substances, such as ice, cast iron, and bismuth? HEAT.

February 8th.

A Lunar Rainbow.

LAST night, after 10 p.m., a thunderstorm passed over this town, travelling from west to east. When the storm had passed and the rain had almost ceased, a bright quarter-moon shone brilliantly almost overhead. To the east the clouds were still very heavy and dark, and in that direction there appeared a perfect rainbow. The arc of the bow was low; it appeared as a grey band with a certain suggestion of colour, against the dark leaden sky.

I should be glad to know from any of your readers if such moon rainbows are of common occurrence, as the one of last night is the first which I have seen.

Pretoria, Transvaal, January 15. J. MCCRAE.

NOTES ON STONEHENGE.[1]

III.—THE EARLIEST CIRCLES.

WHEN we come to examine Stonehenge carefully in relation to the orientation theory, it soon becomes clear that its outer circle of upright stones with lintels and the inner naos, built of trilithons, oriented in the line of the "avenue" and the summer solstice sunrise, are not the only things to be considered. These stones, all composed of sarsen, which, be it remarked, have been trimmed and tooled, are not alone in question. We have:—

(1) An interior circle broken in many places, and other stones near the naos, composed of stones,

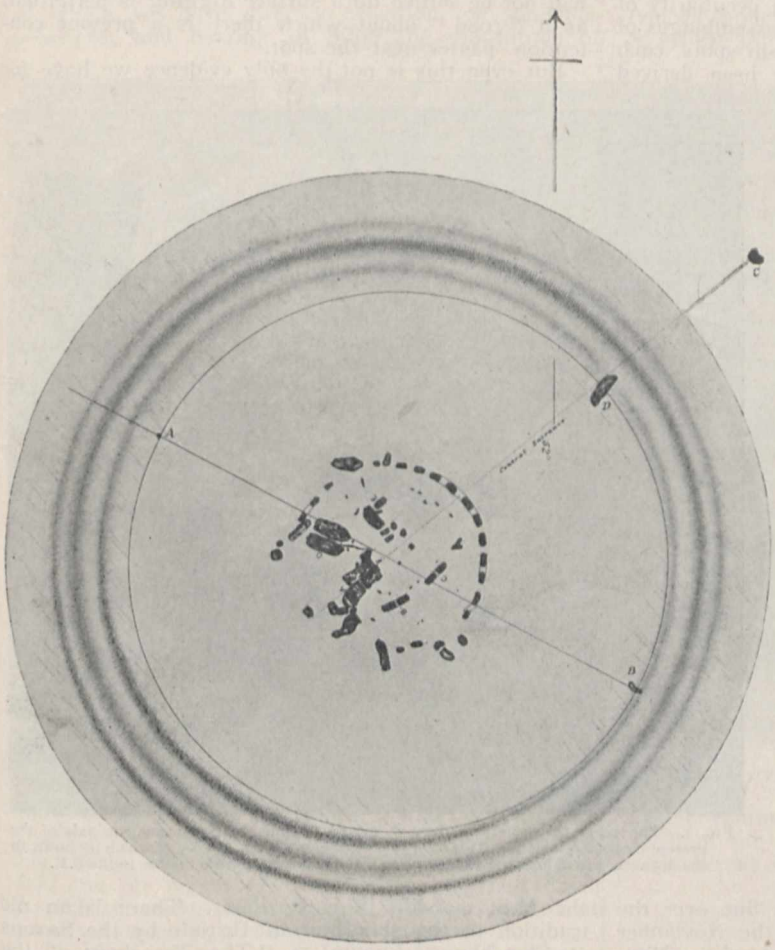


FIG. 8.—Map of the Stones made by the Ordnance Survey. A, N.W. stone; B, S.E. stone; C, Friar's Heel; D, Slaughter stone.

"blue stones," which, as we have seen, are of an entirely different origin and composition.

(2) Two smaller *untrimmed* sarsen stones lying near the vallum, *not* at the same distance from it, the line joining them passing nearly, but not quite, through the centre of the sarsen circle. The amplitude of the line joining them is approximately 26° S. of E. and 26° N. of W. Of these the stump of the N.W. stone is situated 22 feet from the top of the vallum according to the Ordnance plan. The S.E. stone has fallen, but according to careful observations and measurements by Mr. Penrose, when erect its centre was 14 feet from the top of the vallum. The centre of the line joining the stones is therefore 4 feet to the S.E. of the axis of the present circles, which, it may be stated, passes 3 feet to the N.W. of the N.W. edge of the Friar's Heel (see Fig. 8).

There are besides these two large *untrimmed* sarsen stones, one standing some distance outside the vallum, one recumbent, lying on the vallum, both nearly, but not quite, in the sunrise line as viewed from the centre of the sarsen circle. These are termed the "Friar's Heel" and "Slaughter Stone" respectively.

I will deal with (1) first, and begin by another quotation from Mr. Cunnington, who displayed great acumen in dealing with the smaller stones not sarsens.

"The most important consideration connected with the smaller stones, and one which in its archæological bearing has been too much overlooked, is the fact of their having been brought from a great distance. I expressed an opinion on this subject in a lecture delivered at Devizes more than eighteen years ago, and I have been increasingly impressed with it since. I believe that these stones would not have been brought from such a distance to a spot where an abundance of building stones equally suitable in every respect already existed, unless some special or religious value had been attached to them. This goes far to prove that Stonehenge was *originally a temple*, and neither a monument raised to the memory of the dead, nor an astronomical calendar or almanac.

"It has been suggested that they were Danams, or the offerings of successive votaries. Would there in such case have been such uniformity of design or would they have been all alike of foreign materials? I would make one remark about the small impost of a trilithon of syenite, now lying prostrate within the circle. One writer has followed another in taking it for granted that there must have been a second, corresponding with it, on the opposite side. Of this there is neither proof nor record, not a trace of one having been seen by any person who has written on the subject. This small impost, not being of sarsen, but syenite, must have belonged to the original old circle; *it may even have suggested to the builders of the present Stonehenge the idea of the large imposts and trilithons, with their tenons and mortices.*"

In Prof. Gowland's examination of the contents of the holes necessarily dug in his operations, it was found that the quantity of blue stone chippings was much greater than that from the sarsen stones. While the sarsen stones had only been worked or tooled on their surface, the blue stones had been hewed and trimmed in extraordinary fashion; indeed, it is stated by Prof. Judd that some of them had been reduced to half their original dimensions in this process, though evidence of this statement is not given.

It seems, then, that when the sarsen stones were set up, the sarsen and blue stones were treated very differently. This being so, the following quotation from Prof. Judd's "Note" is interesting (*Archæologia*, lviii., p. 81):—

[1] Continued from p. 342.

"I may repeat my conviction that if the prevalent beliefs and traditions concerning Stonehenge were true, and the 'bluestone' circles were transported from some distant locality, either as trophies of war, or as the sacred treasures of a wandering tribe, it is quite inconceivable that they should have been hewed and chipped, as we now know them to have been, and reduced in some cases to half their dimensions, *after having been carried with enormous difficulty over land and water, and over hills and valleys*. On the other hand, in the glacial drift, which once probably thinly covered the district, the glacial deposits dying out very gradually as we proceed southwards, we have a source from which such stones might probably have been derived. It is quite a well-known peculiarity of the glacial drift to exhibit considerable assemblages of stones of a particular character at certain spots, each of these assemblages having probably been derived from the same source.

"I would therefore suggest as probable that when the early inhabitants of this island commenced the erection of Stonehenge, Salisbury Plain was sprinkled over thickly with the great white masses of the sarsen-stones ('grey wethers'), and much more sparingly with darker coloured boulders (the so-called 'blue-stones'), the last relics of the glacial drift, which have been nearly denuded away. From these two kinds of materials the stones suitable for the contemplated temple were selected. It is even possible that the abundance and association of these two kinds of materials, so strikingly contrasted in colour and appearance, at a particular spot, may not only have decided the site, but to some extent, have suggested the architectural features of the noble structure of Stonehenge."

If we grant everything that Prof. Judd states, the question remains—why did the same men at the same time treat the sarsen and blue stones so differently in the same place?

I shall show subsequently that there is a definite answer to the question on one assumption.

I next come to (2). The important point about these stones is that with the amplitude 26°, at Stonehenge, a line from the centre of the circle over the N.W. stone would mark the sunset place in the first week in May, and a line over the S.E. stone would similarly deal with the November sunrise. We are thus brought in presence of the May-November year.

Another point about these stones is that they are not at the same distance from the centre of the sarsen stone circle, which itself is concentric with the temenos mound; this is why they lie at different distances from the mound. Further, a line drawn from the point of the Friar's Heel and the now recumbent Slaughter Stone with the amplitude determined by Mr. Penrose and myself for the summer solstice sunrise in 1680 B.C. cuts the line joining the stones at the middle point, suggesting that the four untrimmed sarsen stones provided alignments both for the May and June years at about that date.

Nor is this all; the so-called tumuli within the vallum may merely have been observation mounds, for the lines passing from the northern tumulus over the N.W. stone and from the southern tumulus over the S.E. one are parallel to the avenue, and therefore represent the solstitial orientation.

So much, then, for the stones. We see that, dealing only with the untrimmed sarsens that remain, the places of the May sunset and June and November sunrises were marked from the same central point.

Statements have been made that there was the stump of another stone near the vallum to the S.W., in the line of the Friar's Heel and Slaughter Stone, produced backwards, at the same distance from the old centre as the N.W. and S.E. stones. This stone was not found in an exploration by Sir Edmund Antrobus, Mr. Penrose, and Mr. Howard Payn by means of a sword and an auger. But the question will not be settled until surface digging is permitted, as a "road" about which there is a present contention passes near the spot.

But even this is not the only evidence we have for the May worship in early times. There is an old tradition of the slaughter of Britons by the Saxons at Stonehenge, known as "The Treachery of the Long Knives"; according to some accounts, 460 British chieftains were killed while attending a banquet and conference. Now at what time of the year did this take place? Was it at the summer solstice on June 21? I have gathered from Guest's "Mabinogion," vol. ii. p. 433, and Davies's "Mythology of the British Druids," p. 333, that *the banquet took place on May eve "Meinvethydd."* Is it likely that this date would have been chosen in a solar temple dedicated exclusively to the solstice?

Now the theory to which my work and thought have led me is that the megalithic structures at Stonehenge—the worked sarsens with their mortices and lintels, and above all the trilithons of the magnificent naos—represent a re-dedication and a re-construction, on a much more imposing plan and scale, of a much older temple.

NORMAN LOCKYER.

FIG. 9.—The rod on the recumbent stone is placed in and along the common axis of the present circle and avenue. It is seen that the Friar's Heel, the top of which is shown in the distance, would hide the sunrise place if the axis were a little further to the S.E.

ANIMAL LIFE.[1]

WITH the appearance of this half-volume we have to congratulate the author and his publishers on the completion of a work which must have involved an enormous amount of labour, and which, in this country at any rate, is unique. The great impulse which has of late years been given to "nature-teaching" rendered a work of this class almost essential (for the mode of treatment could not have been adopted in a systematic natural history), and Prof. Davis has realised the want, and done his best to supply what was required.

In spite of certain errors and blemishes, to some of which we have directed attention on previous occasions, and bearing in mind the magnitude of the task for a single individual, it may be safely said that, on the whole, the author has been successful in his efforts, and that when a second edition is called for, and the necessary emendations and corrections have been made, the work will take its place as an important popular text-book of bionomics.

FIG 1.—Mexican Poisonous Lizard (*Heloderma horridum*). From "The Natural History of Animals."

The half-volume now before us includes some of the most interesting sections of the whole subject, discussing as it does the economic aspect of zoology, the natural history of sport, animals as pets, geographical distribution, the palæontological record, and the doctrine of evolution and heredity. Unfortunately, the author has not allowed sufficient space for some of these subjects. Fur-bearing animals are, for instance, very imperfectly described, no mention being made of such important furs as Arctic and silver fox, otter and nutria; and if only the author had left out the "old wives' tales" about the shrew on pp. 319 and 320 he would have had ample room for proper treatment.

Neither is the volume altogether free from down-right errors. For instance, the statement on p. 313 that Lake Baikal was recently connected with the sea is totally opposed to modern views; and it is equally untrue that the great Indian rhinoceros "bites" (p. 373), while the statement (p. 421) that there are no wild oxen in Africa at least requires qualification. On p. 469 we find the usual exaggerated statement of the size of dinosaurs (115 instead of 60 or 70 feet!). Among misspelt names it must suffice to mention (p. 430) *Padus* for *Pudua*, and (p. 432) *Euneces* for *Eunectes* (we can guess whence the author copied the latter); but it may be added that Saccomyidæ is not the proper title for the pocket-gophers, or Euspongia for the typical sponges. An expression on p. 375 leads one to believe that the author is unaware of the existence of the Devon and Somerset staghounds; while (p. 379) the term "hunting," as applied to fishes, seems somewhat misplaced.

The section on geographical distribution may perhaps be best described as feeble, the author "wobbling" on the subject of "Wallace's line," and being apparently unacquainted either with the works of Max Weber or with a certain text-book published by the Cambridge University Press. In fairness to his readers the author should have told them that there are distributional divisions of the globe other than those adopted by Dr. Wallace; and also that such divisions are based on the range of mammals and birds, and do not accord with that of several other groups.

The coloured plates render this and its fellow volumes attractive to the general reader, and most of the other illustrations (one of which is here reproduced) are well chosen and well executed.

R. L.

[1] "The Natural History of Animals; the Animal Life of the World in its various Aspects and Relations." By J. R. A. Davis. Half vol. viii. Pp. xviii+261-555. (London: The Gresham Publishing Co., 1904.) Price 7s. net.

THE CONDITION OF CHEMICAL INDUSTRIES IN FRANCE.

THE results of an inquiry into the present condition of French chemical industries are described in the *Revue scientifique* of January 28. The upshot of this inquiry is the recommendation that a society should be founded for France, having its headquarters in Paris, with branches in all large towns in France, with a council consisting of the heads of industrial enterprises, the professors in universities and "lycées," of independent persons, and of all interested in industrial chemistry. The duties of this society should be (1) to suggest and press on the Government solutions of the great economic problems of importance to chemical industry; (2) to collect statistics abroad and to endeavour to gain markets for French products by aid of the consular service; and to devise means to prevent competition between French

manufacturers, and to promote combination among them against their foreign rivals; and (3) to act as an advisory body to industrial chemists, and to take steps to direct the education of young chemists into channels helpful to the progress of chemical industry. It is suggested that the work of the society should be aided by congresses in certain towns, which should be attended by the local manufacturers, as well as by those who carry on the same or similar processes elsewhere. In conclusion, the future president, it is suggested, should be Prof. Haller, who has done so much for the industrial progress of the town and University of Nancy, and who is now professor at the Sorbonne, the University of Paris.

Such are the recommendations of the report. The reasons annexed to these recommendations, which form the earlier part of the report, are derived from numerous letters from and interviews with members of some eighty-two representative firms. The opinions of some of these form amusing reading. Thus we learn from the manufacturers of "eau de Javel," the precursor of bleaching-powder, that Monsieur B., "suffit à l'exploitation." In another case "The brewery has no chemist at all, and gets all its analyses made at the brewing-school." Another firm which produces "some rare bodies" (one would like to know what they are) dismisses the question in almost the historical words which preceded the decapitation of Lavoisier—"Aucun besoin de la collaboration des savants"! Another intelligent manufacturer, designated as X, (1) ventures the daring statement that "the candle industry and chemistry have nothing in common." Oh, shade of Dumas! X (10) does not think that the collaboration of "savants" would be useful in the extraction of dyeing stuffs from wood; and a soap-maker, X (16), who confesses himself ignorant of chemistry, thinks that "chemistry can contribute nothing of use to the soap industry, seeing that soap is always made in the same way"!

These examples show that some educative action is necessary in France. The necessity is also apparent when recent statistics are considered. For while the raw materials exported from Germany have remained practically stationary for the last twenty years, those imported have doubled in value; and while the imports of manufactured products have barely increased in value during the same interval of time, the value of the exported manufactured chemical substances has risen from 200 million marks in 1880 to 352 million marks in 1900. The progress in France, accordingly, is much behind that of Germany. To add insult to injury, the red trousers, so conspicuous in the French Army, were designed originally to encourage the cultivation of the madder plant; the plant is commercially as extinct as the dodo, and the trousers are now dyed with artificial alizarin supplied from Germany! Sacre nom de tonnerre!

As this article is written in the hope of reaching the ignorant, the author, M. Jean Jaubert, has taken some pains to show how many-sided the industrial chemist should be if he is to direct his enterprise intelligently, and he sketches the steps taken by the Germans to secure such general knowledge. The collaboration of manufactories and university professors, the give and take, the university training of the scientific heads of departments in chemical works, account for an increase between 1887 and 1900 in the number of works in Germany from 4235 to 7169; in the number of workmen from 82,000 to 153,000; and for *an increase in the average wage of these workmen from* 38*l.* *to* 50*l.* *a year;* and the average percentage dividend of 121 joint-stock companies, obliged by law to publish their accounts, has risen from 9¾ per cent. in 1888 to 13½ per cent. in 1899. Evidently German chemical industry is prosperous, and profitable to all classes concerned. Indeed, the dividend of artificial colouring companies shows a still better figure; the increase in dividend is from 15 per cent. in 1888 to 20½ per cent. in 1900.

Unfortunately, similar statistics are not furnished for France, either because they do not exist or because they are better concealed.

How can this distressing state of affairs be remedied? To what is industrial France to turn? The opinions of many manufacturers are quoted, and some shall be adduced here. First, secondary education is at fault; all initiative is crushed in the secondary schools, and all pupils are turned out of one uniform mould. But, it is acknowledged, an attempt is being made to remedy this. Second, it is said nearly unanimously, by all those asked for their opinions, that the training of young chemists is not sufficiently practical. There is in the universities too much tendency to train teachers rather than industrial men; and the professors often look down on the commercial side of their science. The union of science and industry is recommended. Like ourselves, the French manufacturers, ignorant themselves, often engage a young chemist, and expect him at once to know all about their work and to be able to devise improvements; when they find out that he is of little value they contemn chemistry, as we have seen in what precedes. Others complain that they have to pay their chemists for a year or a year and a half while he is learning their needs; and yet it is acknowledged that no education in a technical school can be of any value; for the teacher cannot teach anything worth knowing about the really important dodges employed by the manufacturer, nor is he welcomed in the work if he lectures on any special process. In a minority of works the German system is followed; young men are engaged as juniors, and work under the supervision of seniors; according to the ability and tastes which they show for routine work, for management, or for invention, they are kept as analysts, made managers, or left in the research laboratory. But it is justly remarked that this excellent plan is impossible for small manufacturers.

In many (most?) cases the difficulty lies in the smallness of the remuneration. It appears common for a chemist to receive 48*l.* to 72*l.* a year, rare for the pay to exceed 100*l.* Now that is little more than workmen's wages; and it is the reward of an expensive education. Yet the manufacturer often grumbles at having to teach such young men their business, and says that they should pay for his tuition; and on the other hand, the chemist who has survived the kicks, cuffs and insults from the foreman, and hard work of the first year, and has acquired some practical knowledge, does not see why he should not better himself if he can.

Again, German firms employ chemists in many walks of life. A man who is a chemist makes a much better traveller for a chemical firm than an ignoramus who can only tout his goods; and their chemists, if they show commercial ability, often take to the business side of the concern, and they know chemistry is a recommendation, not a drawback.

In spite of the low pay, France, according to all reports, is overcrowded with chemists. Some pity them; others think that this plethora will lead to the survival of the fittest. The old-fashioned foreman is as undying in France as here, however, and as opposed to any attempt at innovation. Yet he is being displaced by chemists in some works; and this, common in Germany, is one of the chief causes of her industrial prosperity. The foreman, knowing some tips of importance, looks askance at anyone

who attacks experimentally the problems of his manufactures; for he knows if they are once discovered his use is past. On the other hand, if foreman work is done by a chemist, trained in experimental methods and anxious to improve his product (and his position), reforms can be made, and are willingly undertaken. We in England are in a similar plight; one of the greatest preventives to progress is the foreman. Why, many chemists would be glad of his 3*l.* a week, and would be infinitely more useful.

A closer intimacy between professor and manufacturer is strongly urged. But in France there is apparently mutual distrust. The standing of the professors is low, for one thing, the best paid post (at Paris) bringing in only 800*l.* a year; in the provinces the salaries run from 240*l.* to 400*l.* This contrasts unpleasantly with German salaries, which seldom fall below 600*l.*, and may amount to 3600*l.* In France, many men have a taste for the career of professor, and will work cheap for glory; "that is the French character." Most French professors, according to one of them (rashly named in this article), do nothing and care nothing for industry. In short, collaboration between manufacturer and chemist is wanting owing to jealousy of the latter towards colleagues who meddle with industrial problems, to ignorance and shyness of both parties, and to the want of any intermediary who can bring them into contact.

Besides the recommendations stated in the outset, it is advised that special schools be created, *e.g.* for perfumes, for colours, for soaps, where young chemists shall receive special training.

Now what can we in England learn from this exhaustive discussion? We have many of the same defects; we suffer from the supremacy of the foreman; from the want of interest in industry of the professors (although this is lessening); from the want of intelligence and scientific training of many manufacturers; and from the lack of special schools. In the old days of the Le Blanc soda process the works served as schools for young chemists; now things are too specialised. In prosperous times, the manufacturer does not see the need of a chemist; when bad times come, the luxury of a chemist cannot be afforded. What we want, what the Germans have got, and what the Americans are rapidly getting, is a race of scientifically trained manufacturers; combinations of those engaged in the same industry, so that common laboratories of research may be kept running; the replacement of rule-of-thumb foremen by chemically trained submanagers of a better class, who have had something in the nature of a scientific education, and who are imbued with the spirit of research, leading them to keep their eyes open to every possible improvement; this they would gain first in actual educational establishments, under the guidance of capable professors, and later in the special laboratories mentioned above; and lastly, thorough cooperation between teachers and manufacturers, so that problems capable of being solved in a university laboratory, and of scientific interest, should be transferred there, with the prospect of an ultimate reward should they prove commercially useful; and a liberal attitude of mind on the part of manufacturers, so that they would take a little trouble to become acquainted with the progress of scientific chemistry, with the view of its utilisation for money-making purposes, and a readiness to consider any problems suggested in the university laboratory, with the view of their being worked out industrially. We are moving slowly towards attaining this ideal. Is it any comfort that France appears on her own showing to be more backward? Until the people concerned learn to view such problems from a scientific standpoint, little more can be done. The only thing is for those who can to preach, and above all to practise. W. R.

NOTES.

THE new session of Parliament was opened on Tuesday by the King, who was accompanied by the Queen, with the customary ceremonial. The King's speech to the House of Commons announced that provisions for amending the laws relating to education in Scotland will again be brought forward, and that a proposal for establishing a Minister of Commerce and Industry will be introduced.

AT the annual meeting of the Royal Astronomical Society on Friday last, the gold medal of the society, awarded by the council to Prof. Boss, director of the Dudley Observatory, Albany, New York State, was received by Mr. Choate, the United States Ambassador, for transmission to Prof. Boss. The president afterwards handed to the secretary the Jackson-Gwilt bronze medal for transmission to Mr. Tebbutt, who for many years has carried on astronomical research in his observatory in New South Wales.

AT a meeting of the trustees of the Percy Sladen fund, held at the Linnean Society, Burlington House, on February 3, grants varying in amount were made to Mr. W. R. Ogilvie Grant, toward the expenses of a collector for the British Museum in Central Africa; to Miss Alice L. Embleton, to enable her to continue her investigations in insect cytology; and to Mr. J. Stanley Gardiner, toward the expenses of an expedition to the Indian Ocean.

M. RADAU has been appointed president, Vice-Admiral Fournier vice-president, and M. Bigourdan secretary of the Bureau des Longitudes, Paris.

M. F. J. P. FOLIE, honorary director of the Royal Observatory at Brussels, died at Liège on January 29 in his seventy-second year.

WE regret to see the announcement of the death of Mr. Robert Tucker, who was for thirty-five years (November, 1867–November, 1902) honorary secretary of the London Mathematical Society.

REUTER states that the Argentine sloop of war *Uruguay*, last reported at Punta Arenas, has returned to Buenos Ayres after her voyage in the Antarctic seas, having failed to obtain any news of the French Antarctic Expedition under Dr. Charcot.

IT is proposed to establish an International Association of Anatomists at a meeting to be held at Geneva on August 7–10. The initiative has been taken by the anatomists of the Swiss universities and has the support of the anatomical societies of Germany, Great Britain, France, Italy, and America.

THE *Athenaeum* announces the death, on January 29, of Prof. H. Landois, professor of zoology and director of the Zoological Garden at Munster, in his seventieth year. Prof. Landois was the author of "Der Mensch und das Tierreich," "Das Pflanzenreich," "Das Mineralreich," and other works.

CAPTAIN JOHN DONNELL SMITH, of Baltimore, has given, says *Science*, to the Smithsonian Institution his private herbarium consisting of more than 100,000 mounted sheets and his botanical library of nearly 1600 bound volumes. Captain Smith's collection is probably the largest private herbarium in America, being very rich in tropical plants.

A TELEGRAM has been received at the office of the Scottish National Antarctic Expedition in Edinburgh announcing the safe arrival at Buenos Ayres of Mr. R. C. Mossman, who was left in charge of the meteorological station at Scotia Bay, South Orkneys, last February. Mr. Mossman has spent two continuous years in the Antarctic regions.

THE Treasury has agreed to make a contribution from public funds toward the cost of establishing and maintaining a national museum and a national library in Wales, on the condition that sufficient local support is forthcoming. The Lord President of the Council has appointed a committee of the Privy Council to consider and determine the place at which each of the two institutions should be established and other matters relating to their foundation and future maintenance.

M. JACQUES FAURE accomplished a successful voyage in a balloon from London to Paris on February 12. He left the Crystal Palace at 6.45 p.m. on February 11 with M. Hubert Latham, and they at once rose to a height of 500 metres, which they kept until within sight of the sea, near Hastings. They then descended until the guide-rope touched the water, when they travelled at the rate of 110 kilometres an hour. At 10 p.m., seeing a lighthouse, they rose to 2000 metres, and soon passed over Dieppe. The balloon descended at St. Denis, outside Paris, six hours after starting.

WE regret to see the announcement of the death of Mr. William Sellers, the eminent mechanical engineer of Philadelphia. When president of the Franklin Institute in 1864, he read a paper on screw-threads and nuts, and his form of thread subsequently became the standard for the United States. He had many friends in this country. He was a member of the Institution of Civil Engineers, and as chairman of the Philadelphia committee took an active part in the reception of the Iron and Steel Institute in its recent visit to America.

THE new Premier diamond-mine, situated about twenty miles W.N.W. of Pretoria, in the Transvaal, produced in January of this year an enormous diamond far surpassing in size the largest previously known. It measures $4\frac{1}{2} \times 2\frac{1}{4}$ inches, is said to be of excellent quality, and weighs 3032 carats (=$676\frac{1}{2}$ grams, or nearly $1\frac{1}{2}$ lb. avoirdupois). The largest diamond previously discovered is the "Excelsior," which was found in 1893 in the Jagersfontein mine, Orange River Colony, and was valued at 1,000,000*l*. It was as large as a hen's egg, weighed $971\frac{3}{4}$ carats, and has been cut into nine brilliants. The world-famous Indian diamonds, the "Koh-i-noor" and "Great Mogul," are considerably smaller than the "Excelsior," and compared with this huge latest-found diamond their size sinks into insignificance. An account of the Premier mine was recently published in the report for 1903 of the Geological Survey of the Transvaal (NATURE, 1904, lxxi., p. 55). The mine was opened up in 1902, since when it has produced a rich yield. It is of the same type as the Kimberley mines, but considerably larger in size. The pipe containing the "blue-ground" has an oval-shaped cross-section; its longer diameter measures just over half a mile, and its area is estimated at 350,000 square yards. The pipe breaks through felsitic rocks, which were earlier intruded in the quartzites of the Pretoria series.

"NOTES on Phosphorescence in Plants and Animals" is the title of a paper by Miss Bage in the *Victorian Naturalist* for November last, of which the author has been good enough to send us a copy. Special attention is directed to the occurrence of phosphorescence in butchers' meat, since a remarkable prevalence of this has been recently noticed in Melbourne. So far as the author could ascertain, no cultures have been taken from phosphorescent meat, so that the bacteria by which the phenomenon is produced are still unknown.

The Times of February 9 devotes nearly a whole column to the collection of giraffes in the Natural History Museum, which has recently been enriched by examples of the Kilimanjaro and Nigerian races. The article mentions the names of the various donors of the series in the national collection, which is altogether unrivalled. Brief reference is made to the earlier specimens of giraffes brought to this country, and to the history of the evolution of our knowledge of the local variations of the species. In conclusion, special attention is directed to the importance of ascertaining the reason for these and analogous colour-variations in animals.

WE have received copies of Nos. 1 to 3 of the fourth volume of the Goeldi Museum at Para, the first of which is dated February, while the other two were published in December, 1904. The catalogue of Para mammals in No. 1, by Messrs. Goeldi and Hagmann, has been already noticed in our columns. Among the contents of Nos. 2 and 3, mention may be made of a list of the mosquitoes of Para by Dr. Goeldi, with an account of the measures taken to exterminate *Stegomyia fasciata* and *Culex fatigans*, and also of Dr. Hagmann's synopsis of the birds described by Spix, Wied, Burmeister, and Pelzeln. Considerable interest attaches to a paper on a disease which has recently affected domesticated animals in the Island of Marajo.

THE *Scientific American* of January 21 contains an illustrated account of the setting-up in the American Museum of Natural History, New York, of a skeleton of the dinosaur Brontosaurus, obtained from the deposits near the famous Bone Cabin Quarry in 1898. The skeleton, which is the largest and at the same time the least incomplete specimen of its kind, is being set up under the immediate direction of Prof. Osborn, and will be the only mounted example of the bony framework of the brontosaur. Its estimated length is sixty-two feet. Contrasted with that of Diplodocus, the skeleton of Brontosaurus is characterised by its relatively shorter body and limbs, and its more massive general structure, the arrangements for lightening its weight being more specialised than in any other member of the group. From the rough terminal surfaces of the limb-bones it is inferred that the creature was largely aquatic in its habits; and when sitting down it is supposed that the weight of the body was partly supported by the extremities of the ischia and pubes, which may have been furnished with elastic pads of cartilage or connective tissue.

THE "One and All" Annual, 1905, contains a number of articles connected with gardening, among which are some practical notes on growing mushrooms, celery and herbs.

THE Japanese have a malted preparation, known as ame, which is a kind of candy or barley-sugar, made by the action of barley malt on glutinous rice. Midzu-ame, or liquefied ame, a syrup, forms the subject of an article by Prof. F. H. Storer and Mr. G. W. Rolfe in vol. iii. part iv. of the *Bulletin* of the Bussey Institution, Harvard University. The preparation of ame dates back many centuries, and it is interesting to compare it with *must*, or the more modern wort. Prof. Storey also describes some experiments made with pop-corn which bear out the opinions of previous investigators that popping is caused by bursting of the starch grains.

THE experiments described by Dr. M. Koernicke in the October (1904) number of the monthly journal *Himmel und Erde* prove that both Röntgen and radium rays can produce a very marked action on plants. The general result of exposure of seedlings was to cause retardation and eventually cessation of growth of stem and root; in some cases growth was resumed after an interval, in others the plants never recovered. The first effect of the rays on dry bean and turnip seeds was to accelerate germination, but while the beans ceased to develop after a time, the turnips did not even show signs of retardation; had the exposure been longer, then undoubtedly the turnips would also have reacted.

THE latest number of the *Izvestia* of the Russian Geographical Society (1904, i. and ii.) contains a further report by Colonel Novitsky on his explorations of the range of Peter I., and an interesting and detailed geographical sketch by A. Dunin-Gorkavitch of the northern portions of the government of Tobolsk and its inhabitants. The latter paper is accompanied by a new map of the province, on a scale of 27 miles to the inch, which gives with special detail the inhabitable portions of this immense region. M. Dubyago gives the results of new pendulum observations in the Urals.

A "CONFERENCE NUMBER" of the *West Indian Bulletin* has just been published (46 pp.). It relates to the agricultural conference held at Trinidad on January 4–13, and contains the list of the representatives from the several West Indian colonies who attended; an account of the reception by Sir Henry Jackson, the Governor of Trinidad; a verbatim report of the presidential address by Sir Daniel Morris; and an abstract of the proceedings at the conference and social gatherings. A full account of the papers and discussions will form No. 4 of vol. v. and No. 1 of vol. vi. of the *Bulletin*, and afford valuable information on the great progress made in scientific agriculture in the colonies since the Imperial Department was called into existence by Mr. Chamberlain a few years ago.

WE have received a copy of the meteorological observations made at the Adelaide Observatory and other places in South Australia during the years 1900–1901, under the direction of Sir Charles Todd, Government astronomer. Although the rainfall of some districts is still unrepresented, the monthly and yearly results are published for 463 stations in 1900, and for 474 in 1901, and these are compared with the averages for previous years. This represents a very large amount of valuable work, in addition to that entailed by the usual tables of meteorological results for a large number of stations distributed over the colony. A table is given showing the approximate mean monthly rainfall over the whole of the agricultural districts from the year 1861, and the average yield of wheat per acre. It is pointed out that wheat-growing can only be successfully prosecuted where the percentage of winter rains is largely in excess of that for the summer months, which is only usually the case in the southern districts.

WE are glad to be able to announce the issue of part i. of the new edition of Dr. Hann's excellent "Lehrbuch der Meteorologie." Although so short a period has elapsed since the publication of the first edition, the science has made such important advances, owing to the results obtained from international balloon and kite observations, and from the study of the movements of the upper air by means of cloud observations, that some of the older theories have to be modified, and a new edition has been rendered necessary. We learn from the notice accompanying the part in question that while many details not considered essential to ordinary readers will be omitted, the principles of the theories adopted in recent investigations by men of science, *e.g.* Prof. Bigelow, in the United States, Dr. Shaw, in this country, and Dr. Hildebrandsson, in Sweden, will be included. The work will consist of about six parts; the first deals with air-temperature generally, and with the amount of heat received by and radiated from the solid and fluid surface of the earth. From a communication from Dr. Hann which we lately published we learn that his elaborate meteorological charts will, so far as possible, be extended and include the important additions to our knowledge made by recent expeditions to the Antarctic regions.

FROM Dr. Carmelo Scrivanich we have received a short pamphlet, printed by the Tipographia sociale of Spalato (Italy), dealing with the question of the origin of matter, a subject on which the author invites discussion.

AT the present time investigations of the law of force between two elements carrying currents (Ampère's and allied laws) are commonly regarded as chiefly of academic interest. Several papers on this subject have been written at various times by Dr. Franz Kerntler, of Budapest, and a further paper dealing with the "correct law" as claimed by the same author has just been issued by him. It is published by the Budapester Lloyd Press, and bears the date 1905.

THE internationalisation of scientific literature is well illustrated by the publication in the *Proceedings* of the Academy of Amsterdam of a paper in English by Prof. Sommerfeld, of Aachen, on a simplified deduction of the field and the forces of an electron moving in any given way. The paper is supplementary to one published in the *Göttinger Nachrichten*, and leads to the conclusion that the motion of an electron with velocity exceeding that of light is impossible, as it would require an infinite expenditure of force and energy to maintain it, if the electron be regarded as a sphere with a uniform surface-charge. On the contrary, in the case of a sphere with a bodily-charge the force remains finite. In this problem the electron moves faster than the field of force which it propagates outwards, and a "shadow of motion" is produced. A simple illustration might be afforded by comparison with the effects produced on a sheet of still water by a disturbance moving with a velocity greater than that with which the ripples which it produces radiate outwards.

IN the "Publicationen des astrophysikalischen Observatorium zu Potsdam," No. 41, Dr. Lohse gives the results of a detailed study of the photographic spark spectra of the metals titanium, vanadium, chromium, manganese, iron, nickel, cobalt, molybdenum, palladium, tungsten, iridium, bismuth, lead, uranium, zirconium, lanthanum, cerium, thorium, and didymium. In the majority of cases the region investigated is from λ 340 to λ 400, but for a few metals the record is extended towards the red. Thus, the record for iron goes to λ 446, uranium to λ 431, zirconium to λ 471, lanthanum to λ 567, cerium to λ 467, and didymium to λ 569. The wave-lengths are given to the nearest hundredth of a tenth-metre, and a comparison of these with Rowland's wave-lengths for corresponding solar lines indicates that they are probably correct to within 0·03 tenth-metre in the mean. Lohse has adopted the awkward intensity scale of 0.1 to 10, thus allowing for a hundred gradations. Such a large range is neither necessary nor practicable, and it would have served a better purpose to have kept to the scale 1 to 10 which he used in a previous publication on the same subject. A thorough and detailed knowledge of the spark spectra

of the chemical elements is of primary importance in the proper study of celestial spectra, and Dr. Lohse's record will be very useful in that connection. It seems to us, however, that his work would have been greatly enhanced in value if he had confined his attention to the same region of spectrum for each metal, and had included the portion from λ 400 to λ 486 (F), say, especially as that is the region of stellar spectra most ordinarily investigated.

INDEXES to the literature of gallium (1874–1903) and germanium (1886–1903), prepared by Dr. P. E. Browning, have been issued as parts of vol. xlvi. of the Smithsonian *Collections*.

THE general occurrence of radium in association with uranium has formed an important argument in connection with current views relative to the formation of radium. In a recent note M. Danne states that certain plumbiferous earths in the neighbourhood of Issy-l'Évêque contain radium, but are completely free from uranium. Certain facts seem, however, to indicate that the radium has made its appearance in the pyromorphite at a comparatively recent date through the medium of radio-active water from springs in the neighbourhood.

THE International Committee on Atomic Weights has issued its annual report and a table of numbers for use during 1905. On the basis of new determinations, changes are recommended in the atomic weights of indium, iodine, rubidium, and samarium. As the result of several independent investigations on the atomic weight of iodine, there can now be no reasonable doubt that the value 126·85 given by Stas is too low, and 126·97 is adopted in the new table. The atomic weight of nitrogen would also appear to be much closer to the round number than is represented by the value 14·04 at present in use, and further investigations of this element are needed.

AN interesting paper on the production of calcium cyanamide and its employment in agriculture as fertiliser was recently read by Prof. Frank before the "Klub der Landwirte" in Berlin. As manufactured at present, 250 kilograms of atmospheric nitrogen can be obtained per year in the form of calcium cyanamide for each electric horse-power. The efficiency of the substance as fertiliser has been established by experiments at a large number of agricultural stations, and the combined nitrogen is stated to be as effective as an equal quantity in the form of ammonium sulphate or Chili saltpetre.

THE much discussed question as to the nature of the hydrosulphites has been subjected to further experimental investigation by Messrs. Baumann, Thesmar, and Frossard, and an account of these experiments is given in the *Revue générale des Matières colorantes*, vol. viii., p. 353. The view of Schützenberger that hydrosulphurous acid is to be represented by the formula H_2SO_2 receives strong confirmation. As is pointed out, the crystalline sodium salt $Na_2S_2O_4.2H_2O$ obtained by Bernthsen may be written $NaHSO_2.NaHSO_3.H_2O$, and the behaviour of the mother liquors, from which this salt separates, corresponds with this view. In fact, two formaldehyde compounds corresponding to $NaHSO_2.CH_2O.2H_2O$ and $NaHSO_3.CH_2O.H_2O$ have been separated and analysed.

A NEW booklet has been added by Messrs. Dawbarn and Ward, Ltd., to their "Country House" series of practical handbooks. It is by Mr. D. Grant McIver, and is entitled "Pruning, Training, and Trimming Trees and Shrubs."

MR. JOHN MURRAY has published an attractive English edition of Prof. W. H. Pickering's work on "The Moon," the American edition of which was reviewed in NATURE of May 5, 1904. The work contains a summary of the existing knowledge of our satellite, and the statement of Prof. Pickering's observations and arguments in favour of lunar activities, illustrated with a complete photographic atlas of the moon. The price is two guineas net.

THE second volume of "Papers of the British School at Rome" has been published by Messrs. Macmillan and Co., Ltd. The volume is by Mr. T. Ashby, jun., and is concerned with sixteenth-century drawings of Roman buildings attributed to Andreas Coner. The drawings are preserved in Sir John Soane's Museum at Lincoln's Inn Fields, London. The contents of the sketch-book in which the original drawings are preserved include ground plans, plans and elevations of tombs, elevations, architectural details, Doric entablatures, Ionic and Corinthian entablatures, plain mouldings (cornices and plinths), Doric capitals, and plain and ornate bases. The reproductions of these sixteenth-century drawings which are now available will be of great service for the purposes of study and criticism.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS FOR BROOKS'S COMET, 1904 I.—On a photograph obtained at Greenwich in January the image of Brooks's comet (1904 I.) was quite strong, and indicated that the object was, probably, not fainter than the eleventh magnitude. The following is an ephemeris for this object as given in No. 354 of the *Observatory*.

Ephemeris 12h. M.T. Greenwich.

1905	R.A.	Dec.
	h. m. s.	° ′
Feb. 17	9 55 56	+64 37
,, 23	9 34 55	+64 25
Mar. 1	9 15 34	+63 55
,, 7	8 58 27	+63 11

This ephemeris required corrections of −5s. and −0′.8 on December 7, and shows that the comet is travelling in a westerly direction through the constellation Ursa Major. On March 7 it will be very near to, but S.W. of, τ Ursæ Majoris.

OBSERVATIONS OF COMETS.—A number of photographic and visual observations of Encke's comet were made by M. Quenisset at Nanterre during December. The photographs obtained show that the comet gradually became brighter during the period covered by the observations, and that the coma was extensive and fan-shaped, its extension being in a W.S.W. direction, *i.e.* turned away from the sun. On the photographs this coma was about 4′ in diameter and contained a nucleus which was not at the centre. Visual observations made on December 7 showed the fan-shaped coma to be 5′ or 6′ in diameter with the nucleus situated near to its E.N.E. edge and having a position angle of about 70°, reckoned from the centre of the coma. On this date the comet was at the limit of naked-eye visibility, its estimated stellar magnitude being about 6.5.

Borrelly's comet (1904 *e*) was also observed, photographically and visually, on January 1 and 2 by M. Quenisset, and was seen as a faint nebulosity of 1′.5 to 2′ diameter with ill-defined boundaries. A very faint nucleus of magnitude 11.5 occupied the centre of the coma, and the photograph obtained on January 2 showed a faint tail extending in an E.S.E. direction (*Bulletin de la Société astronomique de France*, February).

ADDITIONAL PERIODICAL COMETS DUE THIS YEAR.—In addition to those periodical comets previously mentioned by Mr. W. T. Lynn as being due at perihelion this year, Mr. Denning, writing to the *Observatory*, mentions Tempel's 1867 comet, which should pass through its perihelion point in April. This object has suffered considerable perturbations from Jupiter, which have lengthened its period from 5.982 to 6.539 years, and have changed its perihelion distance from

1.56 to 2.07. The comet was re-observed on its return in 1873 and in 1879, but has not been seen since.

Wolf's 1884 comet is also due at perihelion in April, but the conditions for its observation will be very unfavourable.

Another comet which may return towards the end of this year is the faint one discovered by Prof. Barnard in 1892. It was not seen, however, in 1899, and, as its exact period is doubtful, although probably about 6½ years, it may again escape detection.

CASTOR A QUADRUPLE STAR.—In a communication to the Astronomical Society of the Pacific (*Publication* No. 99) Prof. Campbell discusses the multiple character of Castor, and states that Dr. Curtis, using the Mills spectrograph attached to the 36-inch refractor of the Lick Observatory, recently discovered that the brighter component of the system is attended by a faint companion. The fainter component was shown by M. Belopolsky, in 1896, to be similarly double, so that in Castor we have a quadruple system in which each component of a visual double is attended by a faint companion. The period of the fainter system is about three days, but further observations of the brighter double will have to be made before its period can be determined.—(*Popular Astronomy*, No. 2, vol. xiii.)

BLOOD PRESSURES IN MAN.[1]

THE lecturer began by contrasting Galen's conception of the oscillation of the blood, about the liver as a centre, with the cardiac circulation of Harvey. The pulmonary circulation—for the purposes of this lecture—was omitted, and attention directed exclusively to that in the systemic arteries.

The physical characters of the flow of fluids were briefly described by the example of water in an open stream. A stream might well up from a spring in a flat country, and swim with very low pressure to its mouth; or, falling from a mountain, might have pressure enough to carry men and horses off their legs. If the volume were also great, as in the sea, it might exercise a pressure of many tons to the square yard, and smash great bulwarks to pieces. But in the higher animals the blood flows in closed channels, so that in such a scheme as theirs the dimensions of the channels assume a very important value. Moreover, in mammalia the circulating fluid is not water, but a thicker fluid—the blood—which (in man) has at least four times the viscosity of water. The enormous value of friction in the circulation was then considered, and it was shown that in this factor the kind of vessel wall does not signify much, as the wall is lined by a practically stationary layer of the fluid; friction, therefore, which uses up 99/100ths of the heart's power, depends on the factor of viscosity together with that of the dimension of the channels, or closed bed. It may be said that the blood pressures—that is, the arterial pressures—in man depend on viscosity and dimension of stream bed.

Now so far the closed tubes had been regarded as rigid. But if in animals the tubes were rigid the circulation would be carried on under great difficulties. For instance, there would be no accommodation; only so much blood could be driven into the system as issued at the periphery; the stream, too, would be quite intermittent, with very high maximum and very low minimum pressures, which would not serve for continuous nutrition, and by its extremes of pressures would soon wear down the arteries. For instance, in the bagpipes, were it not for the air reservoir the sound would issue in spasmodic screams; whereas the air-bag turns the intermittent blowing into a continuous feed of air. In the arterial system of man the same provision is made; its tubing is highly elastic, and a chief part of it—namely, the aorta—being relatively wider than other branches of the tree, contains, like the bagpipe reservoir, accommodation for very variable supplies of output from the heart pump. Thus a very large part of the heart power is used in dilatation of the vessels, and by these is given back to the blood. The valves of the heart serve a like purpose of regulating the pressure of the supply to the vascular system.

[1] Abstract of a lecture delivered by Prof. T. Clifford Allbutt, F.R.S., at the Royal Institution on February 3.

The lecturer in the next place dealt with the pulse, contrasting the travel of the wave with the travel of the blood itself. The wave due to the shock of the heart beat travels, ordinarily, about twenty times as fast as a given particle of the blood itself. The tenser the walls of the arteries the faster the wave travels along the taut vessels, but the slower the passage of the blood itself. Herein lies one of the chief evils of a morbid rise of arterial pressure; more stress on the vessels, less distribution of their contents. Many of these processes were illustrated by lantern slides and demonstrations by Dr. Dixon, demonstrator of pharmacology in Cambridge.

After these principles Dr. Dixon exhibited the various instruments in use for measuring blood pressures in man, and the means by which their curves may be recorded on a revolving drum (kymograph).

The lecturer then entered upon the vital properties of the arteries—that they are not only elastic, and so accommodate themselves to the varying pressures, but are endowed also with nervous governance, whereby they effect a large economy in work and material. Several functions of the human body cannot, save within small limits, work together. If we are digesting we are not apt for thought; the Alpine climber is mercifully unable to worry over affairs—his mind is put into abeyance; and so on. Thus the arterial system, by the means of its nervous connections, contracting in some areas and dilating in others, automatically diverts its fertilising streams hither or thither as needs arise. Moreover, it can enlarge or diminish its bed according to the total quantities of blood temporarily in circulation—a quantity which is very variable. By contracting the arteries in considerable areas and correspondingly dilating them in others, the fields of the various functions of the body can be used alternately, as we see in the irrigation of Alpine meadows. By the same means the very various pressures of the blood can be counteracted. When under muscular effort, for instance, the pressure is raised, a corresponding area outside the muscles is dilated, and pressure more or less equalised; thus the heart is enabled to do the most work with the least disturbance of stresses. So in a bath, cold or very hot, the crimping up of the large cutaneous areas is compensated by large dilatations in internal areas, and pressures return to the normal in two or three minutes. The chief area in which blood can be accommodated, and thus for a time put out of circulation, is a large abdominal area.

By these considerations the lecturer was led to explain why the blood in the body does not drop down into our feet and legs, and leave the brain and other vital parts. Indeed, the blood has a strong disposition thus to obey the action of gravitation, and one of the events of approaching death is the falling of the blood into lower parts of the body, deserting the heart and brain. Obviously this is especially the case in upright animals, as in man chiefly, and in apes in some measure. It is by the vigilance of the nervous governance that the blood is held up, by the contraction of the abdominal vascular fields; and it is the failure of these mechanisms which appears as shock, syncope, or collapse. The lecturer, assisted by demonstrations by Dr. Dixon, illustrated these dispositions, citing especially the researches of Prof. Leonard Hill on the distribution of the blood in various positions of the body. He also referred to the bearing of these principles on the researches of Prof. Waller and others on the dangers of anæsthetics. By some most interesting experiments by Dr. Cushing he showed how enormously the arterial pressures may be raised in case of danger of failure of supply of blood against gravity when, as in apoplexy or a depressed fracture of the skull, the blood-vessels, in the parts of the brain where all these mechanisms find their centres, are compressed and thus more or less liable to be emptied.

In the last part of the lecture the lecturer apologised for occupying time with so much physiology, in which subject he is not an investigator. But it was necessary to make manifest to his audience how great is the importance of the integrity of the arteries themselves, and of their nervous governance in function, an integrity which is a matter of life and death; for if the circulation fails in the nervous centres or heart, life must cease. Now the arteries are subject to many injurious conditions, as of certain poisons and infec-

tions, or of hard muscular labour; there are also the unexplained deteriorations of age. His personal investigations had been into the effects on the arteries of gradual increases of blood pressure. Normally, arterial pressures, as taken in the arm, rise somewhat from childhood to age—say from 80–90 mm. Hg. to 140° or perhaps 150°. These upper limits are not inconsistent with health at the age of three score, though no doubt they signify some loss of mechanical efficiency. A demonstration was given by Dr. Dixon of the difference in vascular efficiency under muscular effort between a young and an elderly man. Into the effect of certain poisons and infections on the arteries he could not enter. Senile degenerations of the arteries are not essentially allied to rise of blood pressure, though in such subjects, as in others, high pressures may arise, and must be, of course, the more dangerous. Still, senile arterial degeneration is compatible with very long life, even if with diminution of function, as the vessels silt up rather than burst.

The lecturer's own observations, now extended over many years, had been upon rise of pressure in middle life beyond, often very far beyond, that which he had regarded as normal for elderly persons. The reasons of this morbid tendency cannot yet be given, but fortunately, by medicinal and dietetic means, it can be abated, and in early stages abolished. If permitted to persist, and it is not rarely consistent with fair general health or but vague indisposition, it slowly ruins the vascular system by overstretching it. It is in such persons that the arteries may break, as in apoplexy, a catastrophe which, by timely precautions, can be prevented. The lecturer strongly urged upon all persons of middle and advancing years to have their arterial pressures tested by their physicians every four or five years, so that any disposition to excessive pressures may be averted and the integrity of the arterial tree preserved.

RADIATION PRESSURE.[1]

A HUNDRED years ago, when the corpuscular theory held almost universal sway, it would have been easier to explain the pressure of light than it is to-day, when it is certain that light is a form of wave-motion. The means at the disposal of early experimenters were inadequate to detect so small a quantity; but if the eighteenth century philosophers had been able to carry out the experiments of Lebedeff and of Nichols and Hull, and had they further known of the emission of corpuscles revealed to us by the kathode stream and by radio-active bodies, there can be little doubt that Young and Fresnel would have had much greater difficulty in dethroning the corpuscular theory and setting up the wave theory in its place. The existence of pressure due to waves, though held by Euler, seems to have dropped out of sight until Maxwell, in 1872, predicted its existence as a consequence of his electromagnetic theory of light. The first suggestion that it is a general property of waves is probably due to Mr. S. T. Preston, who in 1876 pointed out the analogy of the energy-carrying power of a beam of light with the mechanical carriage by belting, and calculated the pressure exerted on the surface of the sun by the issuing radiation. It seems possible that in all cases of energy transfer, momentum, in the direction of transfer, is also passed on and that there is, therefore, a back pressure on the source. Though there is as yet no general and direct dynamical theorem accounting for radiation pressure, Prof. Larmor has given a simple indirect mode of proving the existence of the pressure which applies to all waves in which the average energy density for a given amplitude is inversely as the square of the wave-length. He has shown that when a train of waves is incident normally on a perfectly reflecting surface, the pressure on the surface is equal to $E(1+2u/U)$, where $E/2$ is the energy density just outside the reflector in the incident train, U is the wave-velocity, and u the velocity of the reflector, supposed small in comparison with U. In a similar manner it can be shown that there is a pressure on the source, increased when the source is moving forward, decreased when it is receding. It is essential, however, that we should be able to move the reflecting surface without disturbing the medium except by reflecting the waves.

[1] Address delivered before the Physical Society on February 10 by Prof. J. H. Poynting, F.R.S., president of the society.

Though Larmor's proof is quite convincing, it is interesting to realise the way in which the pressure is produced in the different types of wave-motion. In the case of electromagnetic waves, Maxwell's original mode of treatment is the simplest. A train of waves is regarded as a system of electric and magnetic tubes transverse to the direction of propagation, each kind pressing out sideways, that is, in the direction of propagation. They press against the source from which they issue, against each other as they travel, and against any surface on which they fall. In sound-waves there is a node at the reflecting surface. If the variation of pressure from the undisturbed value were exactly proportional to the displacement of a parallel layer near the surface, and if the displacement were exactly harmonic, then the average pressure would be equal to the normal undisturbed value. But consider a layer of air quite close to the surface. If it moves up a distance, y, towards the surface, the pressure is increased. If it moves an equal distance, y, away from the surface, the pressure is decreased, but to a slightly smaller extent. The excess of pressure during the compression half is greater than its defect during the extension half, and the net result is an average excess of pressure on the reflecting surface. Lord Rayleigh, using Boyle's law, has shown that this average excess should be equal to the average density of the energy just outside the reflecting surface. In the case of transverse waves in an elastic solid, it can be shown that there is a small pressure perpendicular to the planes of shear, that is, in the direction of propagation, and that this small pressure is just equal to the energy density of the waves. The experimental verification of the pressure of elastic solid waves has not yet been accomplished, but the pressure due to sound-waves has been demonstrated by Altberg, working in Lebedeff's laboratory at Moscow, the pressure obtained sometimes rising to as much as 0.24 dyne per sq. cm. By means of a telephone manometer it was found that through a large range the pressure exerted on a surface was proportional to the intensity of the sound.

Both theory and experiment justify the conclusion that when a source is pouring out waves, it is pouring out with them forward momentum which is manifested in the back pressure against the source and in the forward pressure when the waves reach an opposing surface, and which, in the meanwhile, must be regarded as travelling with the train. It was shown that this idea of momentum in a wave-train enables us to see the nature of the action of a beam of light on a surface where it is reflected, absorbed, or refracted without any further appeal to the theory of the wave-motion of which we suppose the light to consist. In the case of total reflection there is a normal force upon the surface, in the case of total absorption there is a force normal to the surface and a tangential force parallel to the surface; while in the case of total refraction there is a normal force which may be regarded as a pull upon the surface or a pressure from within. In any real refraction there will be reflection as well, but with unpolarised light, in the case of glass, a calculation shows that the refraction-pull is always greater than the reflection-push, even at grazing incidence. An experiment, made by the president in conjunction with Dr. Barlow, was described to serve as an illustration of the idea of a beam of light being regarded as a stream of momentum. A rectangular block of glass was suspended by a quartz fibre so that the long axis of the block was horizontal. It was hung in an exhausted case with glass windows, and a horizontal beam of light was directed on to one end of the block so that it entered centrally and emerged centrally from the other end after two internal reflections. Thus a stream of momentum was shifted parallel to itself, or in this particular case a counter-clockwise couple acted on the beam. By suitable means the clockwise couple on the block, due to the pressures at the two internal reflections, was distinctly observed and approximately measured. The result obtained was of the same order as that deduced from the measurement of the energy of the beam by means of a blackened silver disc.

The extreme minuteness of these light forces appears to put them beyond consideration in terrestrial affairs, but in the solar system, where they have freer play, and vast times to work in, their effects may mount up into importance. On the larger bodies the force of the light of the sun is small compared with the gravitational attraction, but as the ratio of the radiation pressure to the gravitation pull varies in-

versely as the radius if the density is constant, the pressure will balance the pull on a spherical absorbing particle of the density of the earth if its diameter is about a hundred-thousandth of an inch. The possible effects of radiation-pressure may be illustrated without going to such fineness as this. In the case of a particle of the density of the earth, and a thousandth of an inch in diameter, going round the sun at the earth's distance, there are two effects due to the sun's radiation. In the first place, the radiation-push is 1/100 of the gravitation-pull, and the result is equivalent to a diminution in the sun's mass. In the second place, the radiation absorbed by the particle and given out again on all sides is crushed up in front as the particle moves forward and is opened out behind. There is thus a slightly greater pressure on the advancing hemisphere than on the receding one, and this appears as a small resisting force in the direction of motion. Through this the particle tends to move in a decreasing orbit, spiralling in towards the sun. As there is good reason to believe that some comets, at least, are composed of clouds of dust, there is hope that some of their eccentricities may be explained by the existence of radiation pressure. If the particles of a dust cloud circling round the sun are of different sizes or densities, the radiation accelerations on them will differ. The larger particles will be less affected than the smaller, will travel faster round a given orbit, and will draw more slowly in towards the sun. Thus a comet of particles of mixed sizes will gradually be degraded into a diffused trail lengthening and broadening, the finer dust on the inner and the coarser on the outer edge. If a planet, while still radiating much energy on its own account, captures and attaches to itself, as a satellite, a cometary cloud of dust in which there are several different grades, with gaps in the scale of size, it may be possible that in course of time the radiation-pressure effects will form the different grades into different rings surrounding the planet. Such may possibly be the origin of the rings of Saturn.

GEOGRAPHICAL RESULTS OF THE TIBET MISSION.

THE paper read by Sir Frank Younghusband at the Royal Geographical Society on Monday, February 13, was one of the most interesting and instructive that the fellows of that society have been privileged to listen to for many years. It afforded a striking exemplification of the advantages of a due coordination of geographical facts and their combination, by a master-hand, into a well-arranged whole. The country traversed by the Tibet mission was by no means a *terra incognita* to the geographer, for its main features had long been known through the labours of the zealous native explorers of the Survey of India. But it is none the less true that Sir Frank Younghusband's admirable descriptions of the conditions of nature and man in that romantic region enabled his audience to realise those conditions in a way that was never before possible, and brushed away many false ideas which had been previously entertained. The speaker was also able to touch briefly upon some of the results obtained by the scientific experts who accompanied the mission, as well as by the survey party under Captains Rawling and Ryder, which in the late autumn did excellent work along the whole course of the Upper Brahmaputra, proving definitely that no peaks higher than Everest exist on this flank of the Himalayas.

In regard to the general nature of the country traversed, Sir F. Younghusband was able to correct the current idea that the whole of Tibet is more or less barren and worthless. This may be true for northern Tibet, the part traversed by recent European explorers, but not for the southern third, which is dotted over with thriving villages and well-built residences. The valleys in which Lhasa, Gyantse, and Shigatse are situated, as well as that of the Brahmaputra, are neither barren plateaux nor narrow, V-shaped gorges, but flat valleys covered with good soil, well irrigated, and richly cultivated. The passage to Tibet, as made by the Kongra-lama Pass, involves, however, a sudden change from the deep-cut valleys and luxuriant vegetation of Sikkim to wide plains on which not a tree is to be seen, while if, in some secluded nook, a plant a foot high is met with it is a curiosity. The summer climate of Khambajong was described as charming, while the unrivalled panorama of the Himalayas, at the very culminating point of their grandeur, is a full compensation for anything that may be otherwise lacking. Sir Frank Younghusband's eloquent descriptions of the snowy range as seen from the north, with the ever-varying atmospheric effects, are of special interest as the first ever given by a European capable of appreciating adequately the glories of the prospect.

The discovery by Mr. Hayden, of the Indian Geological Survey, of a bed of fossil oysters, permitted an accurate determination of the age of the hills in this part of Tibet, showing them to be geologically quite recent, though somewhat older than the main axis of the Himalayan range. The Chumbi Valley, through which the final advance was made, is less wide and open than the valleys in Tibet proper, of which, in fact, it is not considered a part. The passage hence into Tibet, made during the height of winter by the Tang-la Pass, 15,200 feet high, involved much suffering from the effects of the great cold (18° below zero Fahr.) combined with the rarity of the air. The subsequent march over the elevated plateau was made in the teeth of bitter winds and blinding blizzards, which continued through January, February, and March. But on arrival at Gyantse (April 11) the piercing cold was left behind. Willow and poplar trees were bursting into foliage, and the banks of the river were covered with masses of iris-plants, which later on became sheets of purple. On July 14, the day of the start for Lhasa, heavy rain destroyed the delusion that Tibet is a rainless country. Frequent rain was experienced until September, and the size of the rivers showed that this part of Tibet receives —probably up the Brahmaputra Valley—a quite considerable rainfall. Finally, in a lovely valley covered with trees, rich with cultivation, and watered by a river as broad as the Thames at Westminster, the mysterious city which no living European had seen before was at last reached, hidden away by range after range of snowy mountains. It proved anything but a dreamland city, and its streets were horribly muddy, but the grand lama's palace was an imposing, massive structure. Even the leading men were of low mental calibre, having much of the nature of children. The Ti Rimpochi—the leading lama—though benevolent and genial, had few intellectual attainments, and was firmly convinced that the earth was triangular; while the religion of the Tibetans was described as the most degraded form of Buddhism in existence.

THE LONDON CONFERENCE ON SCHOOL HYGIENE.

THE conference on school hygiene, organised by the Royal Sanitary Institute, met on February 8, 9, and 10 at the University of London. Sir Arthur Rücker, who was installed as president of the conference, delivered an address in which he insisted that the elements of education should include some knowledge of the dangers by which mankind is surrounded and of the means to keep them at bay, and that those to whom young lives are entrusted should learn the main outlines of hygiene.

The ignorance of household management and of the principles of hygiene among the poor is responsible in no small measure for their high preventable mortality, their inferior physique, their intemperance and their poverty. How possible it is to better the conditions of modern life, and thus to improve the health, happiness, and physical powers of the people, and thereby their mental vigour and industrial efficiency, is generally recognised, and to this end a suitable hygienic education, moral and material, of the future parents seems essential. Not only have 15,000 medical men and the Commissions on Physical Degeneration recommended that such teaching should be made compulsory, but the English Board of Education and the Scotch Education Department have accepted that recommendation. It is important that from the earliest years of school life children should be taught by example as well as precept the elements of healthy living. The knowledge that may be procured subsequent to that age is often gained at the price of a needlessly costly personal experience. The object, then, of school hygiene is to secure for

the physical life its maximum possibility of sound health, and to develop the mental life side by side with this. The need of bodily health as the foundation of sound mental work is largely recognised at the present day, and we must not rest content until in the homes as well as in the schools there is sound knowledge of what may be done to give the proper environment for healthy life and work.

At the conference considerable prominence was given to the subject of the physical development and physical inspection of the scholar. Fresh air, good light, wholesome food and abundant sleep are essentials of development. These should form, as it were, the compulsory subjects in childhood. The co-relation between the healthy mind and the healthy body is disputed by no one, and yet it is necessary still to plead against the unimportant position which is given to physical education in the curriculum of a large majority of schools, particularly in those for girls. The responsibility of the education authority may be said to be of a dual nature, viz. the responsibility not to injure the child's health during school life either by bad building or furniture, by the discipline or curriculum of the school, or by preventable risks of infection, and the responsibility to take the consequence of its own defective training of the future parent. The relative merits of systems and methods of physical training were not discussed, but free play was held to be preferable to gymnastics for physical training. The methods in the former are more spontaneous and thorough, and the most enthusiastic disciple of gymnastics does not wish the gymnasium to take the place of our great games. Discipline, prompt and unquestioning obedience to command, is perhaps the greatest gain derived from class drilling. But the lesson in physical exercise is not the only opportunity for paying attention to the needs of the growing child. If the best results are to be produced, the necessary standing and sitting positions of the pupils throughout the rest of the school routine must not be treated with indifference.

The early age at which children commence education and the length of the school day were both objects of adverse comment. It was pointed out that in primary schools children at three years of age pass the same number of hours in school as those of fourteen years of age; and in secondary schools a child of fourteen has allotted to him the same number of hours of work as the youth of nineteen. Longer intervals of rest and recreation and the abolition of home-work for young children were advocated, and it was pointed out that, in the experience of many authorities, the beginning of the day after a night's rest, the commencement of the week after the Saturday and Sunday rest, and the beginning of a term after the rest of the vacation, are the times when the best work is accomplished.

It is at present by no means unusual in many first-grade girls' schools to make the first test which a pupil undergoes a physical one based on a medical inspection. Before a scholarship can be held, physical as well as mental fitness should be required to be shown. It is a waste of public money to allot scholarships to those who are physically unfit to make use of them. But while we may discuss the physical inspection of children as specially referable to the school period of life at which, for convenience, it is conducted, we should keep in mind the bearing of the facts thereby disclosed on the periods of life which precede and follow it. Much educational energy is at present misspent in endeavouring to educate children who are physically unfit, as evidenced in Glasgow by the small proportion of underfed children who reach a reasonable standard of proficiency according to the master's estimate. In this important work of physical inspection the school teacher should be able to co-operate intelligently with the medical man.

Owing to various causes, artificial and economic, thousands of children three years of age are found in English elementary schools. It is a question whether taking the child out of the mother's hands for the greater part of the day, at so tender an age, may not have weakened the maternal instinct. It is certain, on the other hand, that, owing to the high susceptibility to certain infectious diseases amongst such young children, the practice is dangerous; and the conference passed a resolution to the effect that no child should be permitted to begin formal instruction in school classes under the age of six.

The subject of school buildings and equipment is one of great importance. The school premises often need to be improved if they are to illustrate the sanitary precepts which it is necessary to inculcate and if they are to enable the child to pursue its education under the best hygienic environment. The requirements of the Board of Education with reference to the floor space and air space given to each child were subject to some adverse criticism. Surely it may be claimed that as 15 feet is generally recognised as the healthy minimum floor space per child, 10 feet should no longer be officially recognised as sufficient. The school furniture, moreover, generally leaves much to be desired. Observation has shown that the difference in height of the children of the same age may vary from 6 to 11 inches, and this difference in height and growth ought to be provided for in the seats and desks of every class-room if physical deformities are to be prevented. That is to say, the desks and seats should be adjusted to the pupils' bodies, and not the bodies to the desks and seats. Teachers, moreover, must be taught to realise that, though their effective administration may be aided by efficient inspectors, actual daily care in providing fresh air, including cleanliness and teaching the children to use all sanitary appliances with cleanly decency, is a responsibility which cannot be shifted to other people's shoulders. Unfortunately, however, the local authorities themselves need stimulating and educating. Nor is this to be wondered at when one recalls the fact that the English Board of Education, though responsible for the compulsory attendance at school of some 6,000,000 children, is absolutely without expert assistance where problems of health and sanitation are concerned.

The last day of the conference was devoted to discussions upon the training of teachers and scholars in hygiene. Not only must the teacher have a knowledge of hygiene, but he must also be made responsible for the supervision of the hygienic environment of the pupil while at school, and he must ever bear in mind the circumstance that he will probably do most to create a sanitary conscience among the rising generation by example and personal influence. The training in the observation of sanitary precepts is a form of moral training, and if the home influences are antagonistic to those of the school the home influences will often prevail. The dirty and neglected child indicates the necessity of attempting to do something to improve the parent. The teaching of hygiene to the scholars must be suitably graduated to the age and capacities of the scholars; whereas from the very commencement of school life the object lessons of a sanitary environment should always be presented to the child, it is not before he at least reaches the age of seven—and several authorities prefer a later age—that he should commence to receive definite instruction in domestic and personal hygiene.

Subsequent to the age of ten or eleven, the scholar may be taught some of the more elementary scientific principles involved in hygiene precept and practice, but in the whole scheme of teaching hygiene it is only from the broadest point of view the simple and essential laws of health that require to be taught. It is almost sufficient to give to the scholar rules regarding health and reasons for them. If the teacher is to have an intelligent appreciation of the significance of hygienic principles, he must be taught the elements of physiology. The two subjects naturally go hand-in-hand and must be taught together. Their interests mutually reinforce. Physiology gives the basis and hygiene the application.

Reference was made at the conference to the circumstance that it had been repeatedly urged that there is no room for extra subjects such as "hygiene" to be taught at our schools; but surely hygiene, if properly taught, need not contribute to further over-pressure. The subject of hygiene has a great educative value in itself, and there is no subject which can be so easily co-related to many other branches of knowledge. Hygiene could be introduced as the practical outcome of the whole of the science teaching in the school, and, if the subject is properly taught to the teachers, an enthusiastic and intelligent teacher could prepare his or her own scheme of work and obtain the necessary results without the displacement of a single subject at present being taught. The great requirement for success in whatever may be attempted is an enthusiasm which will stimulate both the teacher and scholar to convert knowledge into conviction and conviction into conduct.

In connection with the conference there was a trade exhibition of school building and furnishing appliances, which consisted chiefly of school furniture; and the Board of Education, the Scotch Education Department, the Technical Instruction Department for Ireland, the London County Council, Home Office, &c., contributed loan exhibits.

A conference upon school hygiene, international in character, is to be held in London in 1907.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The subject selected for the Adams Prize in 1906 is "The inequalities in the moon's motion due to the direct action of the planets." The successful candidate will receive about 225*l*.

The syndicate appointed to draw up a scheme of instruction and examination in mining engineering has issued a second and amended report to the Senate. It is proposed that a diploma in mining engineering be granted to students who have passed the previous examination and have kept nine terms, and who have attained an honours standard in geology and chemistry in part i. of the natural sciences tripos and a second class standard in certain of the papers in the special examination in mechanism. The candidates have also to produce a certificate in mechanical drawing. This amended scheme meets the objections which had at one time been raised to the recommendations of the syndicate, and it was warmly welcomed at the discussion in the Senate house a week or two ago.

MR. WILLIAM LORING, formerly fellow of King's College, Cambridge, and late director of education under the County Council of the West Riding of Yorkshire, has been appointed warden of the Goldsmiths' College, New Cross.

Science states that the Emperor of Germany has directed the German Ambassador to the United States to lay before President Roosevelt in official form the suggestion for an exchange of professors between German and American universities which he made to the American Ambassador on New Year's Day.

THE administration of the Board of Education in respect of secondary schools under the board's regulations for secondary schools, as also of charitable trusts and endowments connected therewith, will be conducted in future in the board's offices at Whitehall, and not at South Kensington. All correspondence on these matters should therefore be addressed to the Secretary, Board of Education, Whitehall, London, S.W. This change does not apply to the board's administration under the regulations for evening schools, technical institutions, and schools of art and art classes, which will remain for the present at South Kensington.

IN the *Journal* of the Royal Statistical Society for December 31, Mr. L. L. Price contributes a paper on the accounts of the colleges of Oxford, 1893–1903, with special reference to their agricultural revenues. An interesting feature of the discussions was the reference to the disastrous results arising from the new statutes drawn up by the last commission, consequent on the fact that the work of the commission was done at a time when agriculture was prosperous, and no sooner had the sittings ceased than agricultural depression came on the country, and the resources of the colleges were seriously hampered.

THE trustees of the Peabody Education Fund have, we learn from *Science*, voted to dissolve their trust. An appropriation of 200,000*l*. for the George Peabody School for Teachers in Nashville, Tenn., was made by a unanimous vote, the State and city having together voted an equal sum for the school. This appropriation leaves a fund of approximately 240,000*l*., which will be distributed later among other educational institutions. From the same source we learn that the trustees of Syracuse University are about to construct, with the bequest made to the university by the late Mr. John Lyman, which is said to amount to 40,000*l*., a building to be known as the John Lyman Laboratory of Natural History. Mr. Adolph Lewisohn, of New York, has given 1000*l*. for the reconstruction of the chemical laboratories at Dartmouth College.

THE following recent appointments are announced:—Dr. Ernst Neumann, associate professor of physics at Marburg; Dr. Emil Wiechert, professor of geophysics at Bonn; Dr. Holleman, of Gröningen, professor of inorganic chemistry at Amsterdam; Dr. Bernhard Dessau, of Bologna, professor of physics at Perugia; Dr. C. Russjan, of Cracow, professor of mechanics at Lemberg; Dr. L. Courvoisier, of Heidelberg, observer at the Berlin Observatory; Dr. Ferdinand Henrich, associate professor of chemistry at Erlangen; Dr. Boehm, associate professor of mathematics at Heidelberg; Dr. Kueser, professor of mathematics at Breslau; Dr. Th. Vahlen, of Königsberg, associate professor of mathematics at Greifswald; Dr. M. Weber, professor of mechanics at the Hanover Technical College; Mr. B. H. Camp and Dr. G. D. Richardson, instructors in mathematics at Wesleyan and Yale Universities respectively.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16, 1904.—"On the Influence of the Time Factor on the Correlation between the Barometric Heights at Stations more than 1000 Miles apart." By F. E. **Cave-Browne-Cave**, Girton College, Cambridge. Communicated by Prof. Karl Pearson, F.R.S.

The conclusions drawn from the results given in this paper are as follows:—

(1) The correlation between the barometric readings at two stations upwards of 1000 miles apart depends upon the interval between the readings. In the case of Halifax and Wilmington, the correlation is sensible for at least nine days, and it reaches a maximum for an interval of about sixteen hours in summer and twenty-three in winter. For these stations, and also for St. Helena and Cape Town, the observation at the more easterly station should be taken later for maximum correlation.

(2) There is a considerable correlation between the daily rise at Halifax and Wilmington, and this correlation changes with the interval in a manner somewhat analogous to that in which the correlation between simultaneous heights at two stations approximately on the same meridian depends upon the distance between them.

(3) There are considerable differences between the summer and winter correlations, and these differences are of the same general nature for both pairs of stations considered.

(4) It is possible to predict the barometric height at one station from an earlier height at a second station more than 1000 miles away, with a fair degree of accuracy, the mean observed error for forty dates, taken at random, for Halifax and Wilmington, being 0″·15.

January 19.—"On the Comparative Effects of the Trypanosomata of Gambia Fever and Sleeping Sickness upon Rats." By H. G. **Plimmer**. Communicated by C. J. Martin, F.R.S.

The organisms used in these experiments were given to the author by Col. Bruce, F.R.S., and they were taken from monkeys which had been inoculated in Africa from cases of the respective diseases; so that when the author's experiments were commenced each organism had been through one monkey, and they were therefore similar as regards conditions.

Rats inoculated with the Trypanosomata from Gambia fever lived about two and a half months; the Trypanosomata were present in the blood from about four weeks after inoculation until death. *Post mortem* the organisms were present in the blood and in all the organs; the spleen was very much enlarged, and the liver and kidneys were congested. The lymphatic glands were enlarged.

Rats inoculated with the Trypanosomata from sleeping sickness lived without any symptoms for a period of from six to nine months, when they became paralysed, first in one hind leg and then in the other, and they died in from

two to eight weeks after the paraplegia was complete, living altogether up to eleven or twelve months. At no time were any Trypanosomata found in the blood, nor *post mortem* in the viscera or glands. But in the spinal cord they were present in small numbers, and inoculation of the cord into other rats has produced similar symptoms, whilst inoculation of the organs has been negative. In sections of the spinal cord amœboid and adult forms of the Trypanosoma have been found, and also those lesions which Dr. Mott found in the nervous system of man in cases of sleeping sickness, viz., a considerable cellular exudation around the vessels. This is not found in monkeys, in which the organisms become generalised, and do not get localised in the nervous system as is the case in rats.

These experiments go to show that the organisms associated with the diseases of Gambia fever and sleeping sickness, which are thought by some to be the same disease in different stages, are quite distinct in their effects, and they are also distinct morphologically; that the Trypanosoma of sleeping sickness can be inoculated into rats, which has been denied; and that there is a great similarity in the lesions produced in the nervous systems of man and of rats, and in the localisation of the disease to the nervous system.

From experiments made, a double infection would seem to be quite possible, and to be a likely event in these diseases.

January 26.—"On the Modulus of Torsional Rigidity of Quartz Fibres and its Temperature Coefficient." By Dr. Frank **Horton,** St. John's College, Cambridge, late Mackinnon Student. Communicated by Prof. J. J. Thomson, F.R.S.

In this research the dynamical method of experimenting was employed, and the investigaton was divided into three parts:—

(1) The determination of the absolute value of the torsion modulus.

(2) The variation of the modulus between 15° C. and 100° C.

(3) The variation of the modulus between 20° C. and 1000° C.

The radii of the fibres used were determined by measuring their circumferences, the fibres being rolled between two fine glass capillary tubes and the number of revolutions made in travelling a distance of 5 mm. counted. By this method fibres of diameter 0.001 cm. were measured to 0.01 per cent.

In the second part of the research the jacket enclosing the fibre was heated by using the vapours of various liquids boiling under atmospheric pressure. The modulus of rigidity was found to increase as a linear function of the temperature, but the values of the temperature coefficient of the modulus obtained from different fibres were considerably different. In the experiments between 20° C. and 1000° C. the fibres were suspended inside a platinum tube, which was heated electrically. It was found that the modulus of rigidity increased with the temperature, at first as a linear function of it, but as the temperature rose the rate of increase gradually diminished and a maximum rigidity was attained at about 880° C. After passing this point the rigidity decreased very rapidly with increase of temperature.

"Note on the Cause of the Period of Chemical Induction in the Union of Hydrogen and Chlorine." By D. L. **Chapman** and C. H. **Burgess.** Communicated by Prof. H. B. Dixon.

The induction period in the union of hydrogen and chlorine exposed to light, which has been ascribed by various authors either to a change in the physical condition of the chlorine or of the mixture of hydrogen and chlorine, or to the primary formation of an unstable intermediate compound, has been shown by the authors to be due to impurities. The impurities are those which react with chlorine, such as ammonia and sulphur dioxide. At the ordinary temperature in the dark the reaction between these substances and chlorine is not completed. In the light or by raising the temperature these impurities can be entirely removed by the chlorine. The time required for their removal is the induction period during which the chlorine is rendered incapable of combining with the hydrogen.

It has been hitherto supposed that an induced mixture of hydrogen and chlorine if left to stand for some time in the dark must be again induced before combination will proceed at its normal rate. This is not the case if a quartz actinometer is substituted for a glass one.

"The Theory of Symmetrical Optical Objectives.—Part II." By S. D. **Chalmers.** Communicated by Prof. Larmor, Sec.R.S.

In photographic objectives, consisting of two similar lenses symmetrical to a central stop, the back member is generally corrected for spherical and chromatic aberrations, astigmatism, and curvature of field for distant objects, and thus the whole system is perfectly corrected for unit magnification. The present paper discusses the aberrations for distant objects. In part i. it was proved that, to the first approximation, the above defects are corrected in the whole system when they are corrected in the single member. By geometrical constructions, using the symmetry with respect to the axis and to the stop, these results are extended to practical systems. The paths of parallel rays, incident on the combined system, are obtained from those of two sets of parallel rays incident on the single system; the aberrations of the combined system are expressed in terms of the single system with small errors—negligible in practical systems—due to the image of the stop being imperfect.

"Exterior Ballistics. Error of the Day and other Corrections to Naval Range Tables." By Prof. Geo. **Forbes,** F.R.S.

Gun-sights are always marked for standard conditions of muzzle velocity (m.v.) and air density (a.d.). When either of these change the sights must be corrected. The author finds from theory that if a.d. is increased m fold, and the range is diminished m fold, then the elevation and time-of-flight must be diminished m fold; and, empirically, that up to 10° of elevation (10,000 yards for a 12″ gun) elevation varies very closely as $1/[\text{m.v.}]^2$, as *in vacuo*. On these laws he calculated from the naval range table of a 12″ gun, 850lbs. shot, 2463 m.v., at 2, 4, 6, 8, and 10 thousand yards, the table for a 6″ gun, 100lb. shot, 1960ft. secs. The elevations only differed from the Naval 6″ table by −1, −4, −2, +2, and +4 min. of arc.

The laws, therefore, may be applied with perfect confidence for the comparatively small variations that occur in any one gun.

Linnean Society, January 19.—Prof. W. A. Herdman, F.R.S., president, in the chair.—The Rev T. R. R. **Stebbing** exhibited and explained specimens of Crustacea, in various ways remarkable for structure, habits, habitat, or colouring.—Botanical collecting: Dr. A. **Henry.** The actual methods were briefly alluded to, stress being laid on truthful labelling of the specimens at the moment of collection, instead of months afterwards, when identical numbers were often given to plants of different *provenance*. Dr. Henry described observations made by him in China. He alluded to mimicry in plants, in the case of two species of Lysimachia (a protomorphic genus in China), one of which mimicked *Paris quadrifolia*, with 4 leaves, while the other recalled another species of Paris with 10–12 leaves. He referred also to the extraordinary richness of species on calcareous soils as compared with other soils, a fact constantly seen in China, and well marked also in France, and asked for some explanation. In China, as elsewhere, pure woods were rare, being only formed by a few conifers, like *Abies Fargesii* at high altitudes in Hupeh, *Cupressus funebris* in the same province at lower levels (the home of the Reeves's pheasant), *Pinus Massoniana* (almost everywhere in the central and southern provinces), other species of Pinus more local; also certain species of oak widely distributed; and *Alnus nepalensis* in Yunnan. The explanation of the occurrence of pure forests was also a subject not completely understood: *e.g.* in this country ash seeded freely, and in some places for a time looked as if it would grow into a pure wood; but apparently pure

forests of ash only occurred on extremely rich soil in some districts in Russia. With regard to botanical collecting, three stages had occurred. At an early period plants were collected to be merely named and classified; in fact, they were treated like postage stamps. The second period began with Sir Joseph Hooker, who inaugurated the study of the geographical distribution of plants. The third period, that of the present day, was a step forward, in that attention should be paid to the plants themselves as social organisms, living in harmony and yet in competition together; and Dr. Henry urged that the time had come when the hunt for new species should cease to be the sole aim of the collector, and the study of the known species be taken in hand in their living conditions. He advocated map-making of small areas, census-taking, measurements, records of natural seedlings, soil, shade, &c., and to illustrate this plan showed a series of slides taken in France, the idea of which was to explain how the commoner species of trees behaved at different altitudes and on different soils.—Cranial osteology of the fishes of the families Osteoglossidæ, Pantodontidæ, and Phractolæmidæ: Dr. W. G. **Ridewood.** This paper is a fourth instalment of the results of an extensive investigation upon the skull of the lower teleostean fishes begun in 1896. Descriptions are given of the skulls of Osteoglossum, Heterotis, Arapaima, Pantodon, and Phractolæmus; and in a summary Dr. Ridewood points out that the evidence of the skull goes to show that the three genera Osteoglossum, Heterotis, and Arapaima, first brought together into the family Osteoglossidæ by Dr. Günther, constitute a perfectly natural group; that the Pantodontidæ are more closely related to the Osteoglossidæ than to any other family of fishes, as has been suspected since the first discovery of the genus Pantodon in 1876; and that the Phractolæmidæ do not in their cranial osteology offer any evidence of close alliance with either of these families.

February 2.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Descriptions of some new species and notes on other Chinese plants: W. J. **Tutcher.** The species in question had been found on the island of Hong Kong, with one from Kowloon and one from Wei-hai-wei. Bentham's "Flora Hongkongensis" in 1861 enumerated 1053 species from the island, 159 of which had not at that time been found elsewhere, but at the present time only about 50 of these remain peculiar to the island. The flora as now known amounts to about 1400 species, of which 100 are regarded as endemic, though probably many will be found natives of the mainland. Ferns amount to 100; grasses about as many; Leguminosæ nearly as many; between 70 and 80 Cyperaceæ; Compositæ more than 60, and orchids 60. *Quercus Eyrei*, first found by Capt. Champion, was not collected by any recent collector until the author re-found it in quantity; even Hance had declared that Champion must have been mistaken in his locality. The luxuriance usually associated with tropical vegetation is here wanting, due to the poverty of the soil, which is almost exclusively disintegrated granite. The new territory leased to Great Britain in 1898 has an area of about 300 square miles, that is, ten times the area of Hong Kong. Lantao is an island resembling Hong Kong, but its highest peak is 3050 feet, with many well-wooded ravines, and when explored will doubtless prove rich in plants.—Revision of the European marine forms of the Cirolaninæ, a subfamily of Crustacea Isopoda: Dr. H. J. **Hansen.** Three new species are described—*Cirolana gallica*, *C. Schmidtii*, and *Eurydice affinis*. Comparative tables of the genera and species are supplied, distinguishing eight European species of Cirolana, one of Conilera, and six of Eurydice.

Challenger Society. January 25.—Sir John Murray in the chair.—Mr. E. W. L. **Holt** exhibited and made remarks on some rare and interesting deep-water fish and Crustacea from West Ireland.—Dr. R. N. **Wolfenden** exhibited and made remarks upon some Copepoda from the *Gauss* (German Antarctic) expedition; their large size, up to 10mm., was remarkable, as also the fact that, of the 42 species from the *Gauss* and *Belgica*, five were common to the subpolar seas and continuous by way of the mesoplankton.—Sir John **Murray** spoke on the relation of oceanography to other sciences. He pointed out that recent expeditions had made only inconsiderable alterations in the contour lines of the sea-bottom published in the *Challenger* reports, and was of the opinion that no great changes were likely to be made by the soundings of future expeditions. He expressed his belief that the great ocean basins had been practically unaltered through geological time, but that the continents, including a zone of not more than 200 miles seaward of their present outline, had frequently altered their levels, supporting this belief by the fact that all known sedimentary rocks are of "terrigenous" character, to the exclusion of deep-sea materials. The meteorology of mid-ocean, where the diurnal temperature range of the water is about 2° F., was contrasted with the meteorology over land-masses, where absorption and radiation are high, and the diurnal atmospheric range may amount to 80° F. As an example of the far-reaching effects of temperature, Sir John Murray cited the range of annual variation where hot and cold currents are at war, amounting in some cases to 40° F.; in such regions the animal death-rate is very high, and the dead organisms decomposing on the bottom start the formation of glauconite, a well-known constituent of sedimentary rocks. As another result of temperature, it has been estimated that a tropical Copepod lives twenty-four times as fast as an Arctic Copepod in the same period of time; this may explain the predominance of specimens and paucity of species in the Arctic as compared with the Tropical fauna. In connection with chemistry, he pointed out the gradual transference of lime from the poles to the tropics by organic agency; and, in connection with physiology, the possible relation between the serous and similar fluids of existing organisms, and the constitution of the primæval sea in which life first began on our earth.

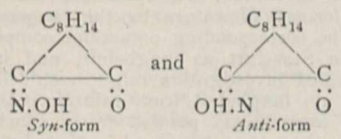
Faraday Society, January 30.—Prof. A. K. Huntington in the chair.—Mass analysis of Muntz's metal by electrolysis, and some notes on the electrolytic properties of this alloy: J. G. A. **Rhodin.** The first portion of the paper describes an apparatus which was specially designed by the author for the purpose of the accurate and rapid determination of the copper content (which should lie between 60·5 and 61·5 per cent.) of Muntz's metal. The author also discusses the electrochemical properties of Muntz's metal. The metal is largely used as a sheathing to protect ships' bottoms from certain mollusca and algæ, and to be successful it should dissolve in sea-water just to a sufficient extent as to render the surface poisonous, the best conditions being the equal dissolution of the copper and zinc. The author shows how these may be calculated approximately by supposing that the electrolytic dissolution rate is proportional to the heat of formation of the ultimate compounds (zinc and cuprous chlorides), and to the conductivities of the metals which dissolve.—The equilibrium between sodium sulphate and magnesium sulphate: R. B. **Denison.** Experiments conducted from the standpoint of the phase rule are described, the object of which was to determine whether the double salt of sodium and magnesium sulphates, $2MgSO_4.Na_2SO_4$, which has been described as a naturally occurring mineral, is capable of existence in contact with solution, that is, whether it has been formed in nature by the evaporation of saline waters. The corresponding potassium compound is known to occur in Stassfurt as langbeinit, and it was thought that a detailed investigation might result in the isolation of the sodium langbeinit from solution. Dilatometer and tensimeter experiments pointed fairly conclusively to the assumption that the compound sodium-langbeinit cannot exist in contact with solution, at least below 100° C., and hence this substance, if found as a mineral, must be a product of a higher temperature.—Refractory materials for furnace linings: E. K. **Scott.**

Mineralogical Society, January 31.—Prof. H. A. Miers, F.R.S., president, in the chair.—Danalite from Wheal Maudlin, Cornwall; crystallographic characters of barium-radium bromide: Prof. H. A. **Miers.**—Epidote from Inverness-shire: H. H. **Thomas.** The crystallographic and optical characters were described. A chemical analysis made by Dr. Pollard showed that the mineral contained a very low

percentage of ferric oxide (6.81). In this respect it was similar to epidotes from Huntington, Mass., and the Zillerthal, and like them showed correspondingly low refractive and double refractive power and large optic axial angle, as compared with epidotes containing higher percentages of iron.—Preliminary note on the regular growth of crystals of one substance upon those of another: T. V. **Barker.** The observations of previous investigators were in general confirmed with regard to the growths of KI, KBr, KCl and $NaNO_3$ upon mica, and of $NaNO_3$ upon calcite. In all cases a clean surface is necessary. Attempts to get a regular deposition of $NaNO_3$ upon other rhombohedral carbonates of the calcite group and upon dolomite were without any positive result, although the rhombohedral angle of some of them is much nearer to that of $NaNO_3$ than is that of calcite. The topic axes, however, are in order of magnitude as follows:—$NaNO_3$, calcite, rhodochrosite, dolomite, chalybite, so that if the regular growth depend on the fitting together of similar structures, the experiments point to the usefulness of the conception of topic axes. The author is continuing his observations.—Apparatus for determining the density of small grains: K. A. K. **Hallowes.** The method is by hydrostatic weighing, and the grain is held under water (or preferably alcohol) in a spring-clamp, made of brass wire and two cover-glasses, which is suspended from the beam of the balance by a fine hair.—*Exhibits*: Specimen of phenacite and one of aurichalcite from Cornish localities: A. **Russell.** —Specimens of sulphide of lead and oxide of zinc artificially produced in furnaces at Laurium: H. F. **Collins.**

Geological Society, February 1.—Dr. J. E. Marr, F.R.S., president, in the chair.—On the sporangium-like organs of *Glossopteris Browniana*, Brongn.: E. A. Newell **Arber.** Some specimens from New South Wales, on which scale-fronds of Glossopteris occur, also exhibit impressions of minute bodies, not unlike the sporangia of certain recent and extinct ferns and cycads. They have never been found, except in the closest association with the scale-leaves of Glossopteris, and this is regarded as an indication that they may be attributed to that genus, a conclusion supported by the evidence of the scale-fronds, which show scars of attachment and fragments of the sac-like bodies still apparently in continuity. It is impossible to be quite certain that these bodies are sporangia, but there is much to be said for this view. The closest analogy may probably be found in the microsporangia of cycads. A historical sketch is given of the present evidence on the subject of the fructification of Glossopteris. If the present conclusion be correct (that the sporangia were borne on the smaller scale-fronds), Glossopteris cannot be included in any recent family of the true ferns.

Chemical Society, February 2.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—Camphorylcarbimide: M. O. **Forster** and H. E. **Fierz.** The authors described this substance and some of its derivatives and reactions.—Configuration of *iso*nitrosocamphor and its unstable modification: M. O. **Forster.** It is proposed to represent *iso*nitrosocamphor and its unstable isomeride by the configurations



Syn-form *Anti*-form

respectively. The evidence for this view is principally based upon the behaviour of the two isomerides towards magnesium methyl iodide.—The determination of molecular weight by lowering of vapour pressure: E. P. **Perman.** The author has worked out the details of a simple method by which molecular weights can be determined with moderate accuracy from measurements of the lowering of vapour pressure of the solvent in which the substance under investigation is dissolved.—Note on β-NH-ethenyldiaminonaphthalene: R. **Meldola** and J. H. **Lane.** The ethenyldiaminonaphthalene, obtained by Prager in 1885 by debrominating the bromo-anhydro-base prepared by the reduction of 4-bromo : 2 : nitroaceto-α-naphthalide, is now shown to be identical with the anhydro-base obtained from Markfeldt's ethenyltriaminonaphthalene by the diazo-method.

Mathematical Society, February 9.—Prof. A. R. Forsyth, president, in the chair.—The president referred to the loss sustained by the society by the death of Mr. R. Tucker, who was honorary secretary of the society from 1867 to 1902. A resolution of condolence with Mr. Tucker's surviving relatives was passed.—The following papers were communicated:—General theory of transfinite numbers and order types: Dr. E. W. **Hobson.** The paper deals with the well-known contradiction which arises in the theory of aggregates, and is expressed in the statements:—The aggregate of all ordinal numbers has an ordinal number which must be the greatest of all ordinal numbers, that is, the last of the series; but the series cannot have a last element. The source of the contradiction is traced to the assumption that an ordered aggregate necessarily possesses a definite order-type which can be regarded as an object, viz. the ordinal number coming immediately after all those which are the elements of the aggregate of which it is the order-type. The author proposes to deny this principle, and points out that those parts of the theory of aggregates which are of importance for the general purposes of mathematical analysis would not be affected by this denial.—The Maclaurin sum-formula: Rev. E. W. **Barnes.** The paper contains a new form for the remainder, and a fresh demonstration of the conditions in which certain generalisations of the formula are valid.—The asymptotic expansion of integral functions of finite non-zero order: Rev. E. W. **Barnes.** The object of the paper is to investigate the asymptotic expansions of functions of the class in question without making any appeal to the theory of divergent series. It is shown that the most general type of integral function of finite non-zero order with a single sequence of non-repeated zeroes admits, when the argument is large, an asymptotic expansion valid everywhere save in the neighbourhood of the zeroes of the function, and all the coefficients of this expansion can be built up from the simple Riemann Zeta function. Expansions are also found in the case of integral functions of multiple linear sequence.—On the function $\sum_{n=1}^{\infty} x^n/n^s$: G. H. **Hardy.**—On the reducibility of covariants of binary quantics of infinite order, part ii.: P. W. **Wood.**

EDINBURGH.

Royal Society, January 23.—Dr. Traquair in the chair.—On deep water ship waves: Lord **Kelvin.** The waves were supposed to be produced by a floating or submerged body of proper form moving forward with a given speed in a canal of rectangular section. A solution of the approximate equations was first obtained for a particular form of surface wave associated with a definite distribution of pressure over part of the surface and moving forward with a given speed of propagation. The vanishing of the pressure distribution or "forcive" occurred for a given speed which coincided with the speed of propagation of the free sinusoidal wave. When the forcive did not vanish it acted with or against the displacement according as the speed of propagation was less or greater than this critical velocity. By a suitable synthesis of a series of distributed forcives with their associated surface displacements, the solution was put in a form which lent itself towards the elucidation of several important problems. Thus in certain cases it was possible to imagine a cover fitting part of the water surface and moving forward with the proper speed associating this form of surface with a definite forcive, and in this way a solution was obtained of the train of waves accompanying the passage of a suitably shaped pontoon over the fluid surface. Again, by superposition of two exactly equal forcives half a wave-length apart, the surface outside the region over which the forcive acted was reduced to rest. The disturbed surface within the region of the acting forcive and moving forward with it could then be imagined as fitted with a cover; and thus was solved the problem

of finding the form of pontoon which, advancing through the fluid at a given speed, would be unaccompanied by any displacement of fluid surface either before or behind.—A comparison of the lakes of Denmark and Scotland: Dr. **Wesenberg-Lund.** Dr. Lund had visited Scotland on the invitation of Sir John Murray with the view of making this comparative study. The greatest possible contrasts existed between the lakes of Denmark and the typical Highland lakes of Scotland, the Danish lakes being, for example, comparatively small and shallow, with great variations of temperature from season to season, the water being rich in lime, and the littoral region being characterised in most cases by luxurious vegetation forming the home of numerous animals. Scottish lakes like Loch Leven, however, approximated more closely in character to the lakes of Denmark. The paper contained an important discussion of the fauna of the two types of lakes, and of its influence on the lakes themselves and their surroundings. The Danish lakes are gradually being silted up, and will before long disappear, while the lochs of Highland Scotland will remain practically unaltered through long ages.—On a new family and twelve new species of Rotifera of the order Bdelloida: J. **Murray.** The great uniformity of structure hitherto observed throughout the order Bdelloida gives much interest to the discovery in the Scottish lochs of an animal showing great divergence from the general type. The new family, which is called Microdinadæ, is peculiar in the structure of head and jaws. The discs and wreaths are quite absent, so that there is no corona, unless the terminal cilia of the throat are regarded as such. The rostrum and toes are as in the genus Philodina. The jaws of all other Bdelloida are *ramate*; those of Microdina are between *ramate* and *malleo-ramate* or *malleate*. The large teeth are all towards the anterior end of the jaws, and there are usually from one to two loops on the manubrium. A remarkable feature of the animal by which alone it could be distinguished from all other Bdelloida is a large crimson gland attached to the œsophagus.—Variations in the crystallisation of potassium hydrogen succinate due to the presence of other metallic compounds in the solution: A. T. **Cameron.** The crystals were obtained from solutions containing small quantities of ferric and chromic compounds, and may be described as oblique elliptic double cones showing curved surfaces only. The crystals belong to the same system as those of the acid succinate, and are evidently modifications due to the presence in small variable quantities of the other metallic compounds possibly in a state of solid solution.—(1) Continuants whose main diagonal is univarial; (2) the eliminant of a set of general ternary quadrics: Dr. Thomas **Muir.**

MANCHESTER.

Literary and Philosophical Society, January 24.—Rigidity of gelatin: H. **Morris-Airey.** After describing some of the properties of aqueous solutions of gelatin, the results of a series of measurements of the rigidity of these media were given.—The cause of the period of chemical induction: C. H. **Burgess** and D. L. **Chapman** (see p. 380).

PARIS.

Academy of Sciences, February 6.—M. H. Poincaré in the chair.—On the stability of ships: E. **Bertin.**—On the action of hail cannons: J. **Violle.** There are in the Beaujolais twenty-eight societies for breaking up the hail-storms common in that region by means of the hail cannon. A comparison of the damage done during the period 1891–1900 with the losses through hail subsequent to the introduction of the cannon (1900–1904) shows marked evidence in favour of the use of this means of dispersing the hail clouds. It has been frequently noticed that both lightning and thunder are suppressed within the protected zone, although they may be raging just outside this area.—Syntheses in the anthracene series. Symmetrical diamido-tetra-alkyl derivatives of the dihydride of γ-tetraphenyl-anthracene: A. **Haller** and A. **Guyot.** As a result of the condensation of γ-diphenyl-γ-dihydroxy-anthracene dihydride with dimethylaniline two stereoisomeric compounds are produced, which, on account of the wide differences in their properties, are very readily separated. A similar reaction takes place with diethylaniline, but the stereoisomers are more difficult to separate.—The substances producing softness in wine: A. **Muntz.** A discussion of the effect of the gummy matters present in wine on its taste.—On the extension of the Cretaceous seas in Africa: A. **de Lapparent.** Traces left by the seas of the Upper Cretaceous have been recognised for some time in the Sahara and the Soudan, but up to the present there has been no direct proof of a communication between this and the Atlantic. Fossils recently collected by Lieut. Desplagnes and Capt. Théveniaud make the existence of this communication highly probable.—On the three methylcyclohexanones and the corresponding methyl-cyclohexanols: Paul **Sabatier** and A. **Mailhe.** The three cresols are readily reduced to the corresponding cyclohexanols by hydrogen in presence of reduced nickel at 200°–220° C. These were converted by heating with zinc chloride into methylcyclohexenes, and by oxidation into methylcyclohexanones. The latter substances are more conveniently obtained from the alcohol by the reaction discovered by Sabatier and Senderens, passing the vapours of the alcohol over copper heated to 300° C., the yield by this method being nearly theoretical.—On a measurement of the height of the reversing layer obtained with the aid of the large telescope of the Observatory of Mont Blanc: M. **Millochau.** Measurements of two calcium lines under good conditions gave a thickness of 0″.15.—Observations of the zodiacal light made at the summit of Mont Blanc: A. **Hansky.** A detailed account of observations taken under very favourable conditions on September 21–22.—On solutions of systems of linear differential equations with monodrome coefficients: Ed. **Maillet.**—On Poisson's integral and singular lines of analytical functions: P. **Fatou.**—On the whole of the curves traced on an algebraic surface, and on the Picard integrals of this surface: Francesco **Severi.**—On the deviation of freely falling bodies: M. **de Sparre.** Reply to a paper of M. Maurice Fouché on the same subject.—On a new mechanical clutch: M. **Hérisson.**—An integrating thermometer: Ch. **Féry.**—A synchronising electromagnetic brake: Henri **Abraham.** The axis of the motor carries a toothed wheel of copper, the teeth of which pass between the poles of an electromagnet, actuated by the same current as the motor. If synchronism is established, each tooth passes this space at the instant when the electromagnetic field is nil, and there is no braking action. If the synchronism is imperfect, the brake absorbs the whole of the extra energy of the motor.—Magnetic hysteresis at high frequencies in nickel and nickel steels: Ch. Eug. **Guye** and A. **Schidlof.**—On the direct fixation of ethero-organo-magnesium derivatives on the ethylene linkage of unsaturated esters: E. E. **Blaise** and A. **Courtot.** Ethyl methacrylate reacts with magnesium-methyl-iodide giving the tertiary alcohol dimethylpropenylcarbinol, the ketone methyl-ethyl-acetone, and diisopropenyl. The conditions giving a maximum yield of either of these have been worked out.—On the cryoscopy of the sulphates: Albert **Colson.**—A new method of testing for ammonia: application to the examination of water for sanitary purposes: MM. **Trillat** and **Turchet.** In presence of potassium iodide and sodium hypochlorite, ammonium salts develop a black coloration, due to iodide of nitrogen, which can be estimated colorimetrically. The coloration appears to be less liable to be interfered with by certain substances commonly present in natural waters than is the case with Nessler's reagent.—On the evolution of carbon in combustibles: Isidore **Bay** and Just **Alix.**—Some hereditary anomalies provoked by traumatisms: M. **Blaringhem.**—On the use of leucine and tyrosine as sources of nitrogen for plants: L. **Lutz.** These two nitrogenous substances can be assimilated both by phanerogams and fungi. The difference noted in a previous paper between these two classes of plants was due to the use of sand as a medium for the growth of the former.—On the cause of the impoverishment of springs in plains: M. **Houllier.** The author draws the conclusion that the progressive impoverishment of the springs in the basin of the Somme during recent years is the result of the increased use of the land for agricultural purposes, leading to a very considerable increase in the amount of water evaporated by plant transpiration.—The proportions of the gases in arterial blood during the course of anæsthesia due to chloroform, remaining invariable so long as the pulmonary respiration remains very nearly normal: J. **Tissot.**—The mechanism of accommodation: H. **Bertin-Sans** and J. **Gagnière.** The experiments described, which were carried out with rabbits' eyes, support

Tscherning's theory, as opposed to that of Helmholtz.—Observations on the absorption bands of blood and oxyhæmoglobin: MM. **Piettre** and **Vila.**—Myelitis produced by tuberculous toxins: E. **Clément.**—On the constitution of Djebel Hadid: Paul **Lemoine.**—On the Eocene strata in Western Morocco: A. **Brives.**—On the mode of formation of high glacial valleys: Paul **Girardin.**

NEW SOUTH WALES.

Royal Society, November 16, 1904.—Mr. C. O. Burge, president, in the chair.—On the occurrence of isolated crystals of augite in the tufaceous mudstones near the top of the upper marine series at Gerringong: H. G. **Foxall.** The author gives the results of crystallographical and chemical examinations of isolated crystals of augite, together with a note on their occurrence.

December 7, 1904.—Mr. C. O. Burge, president, in the chair.—Mr. C. O. Burge delivered his presidential address on the connection between engineering and science. Among the future triumphs of engineering helped by science were mentioned the application of electricity to main line railways. Then there are promises as regards conveyance of power by electricity without wires. Increased economy in the utilisation of heat units in the ordinary steam engine will be a work of the future, thus saving our rapidly diminishing fuel supply. Other subjects mentioned as fit ones for the future were the direct utilisation of the sun's rays for power, and of the rise and fall of the tide for the same purpose; the diminution of skin friction in ships; and of the resistance to air in ships and trains; the dispersion of fog by electricity; the further investigation of fatigue in metals used for construction; and the application of single phase electricity to traction.—The approximate colorimetric estimation of nickel and cobalt in presence of one another: R. W. **Challinor.** Use is made of the complementary colours of Ni and Co solutions. The method is to be applied to the solution of the weighed Ni and Co deposited by electrolysis. The mixed metals are dissolved in HNO_3, the solution evaporated and diluted to a definite volume and a fraction taken. Standard Ni $(NO_3)_2$ or Co $(NO_3)_2$ solution is added until the colour matches a neutral tinted solution of known strength; both solutions are brought finally to the same dilution, the colours being compared by looking vertically down the tubes.—Note on a combined wash-bottle and pipette: J. W. **Hogarth.**

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 16.

ROYAL SOCIETY, at 4.30.—Polarised Röntgen Radiation: Dr. C. G. Barkla.—The Effects of Momentary Stresses in Metals: Prof. B. Hopkinson.—The Halogen Hydrides as Conducting Solvents. Parts I.—IV.: B. D. Steele, D. McIntosh, and E. H. Archibald.—Further Observations on Slip-bands. Preliminary Note: W. Rosenhain.

ROYAL INSTITUTION, at 5.—Recent Work of the Geological Survey: Prof. J. J. H. Teall, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Indian Census of 1901: Sir Charles A. Elliott, K.C.S.I.

LINNEAN SOCIETY, at 8.—A Revised Classification of Roses: J. G. Baker, F.R.S.—The Botany of the Anglo-German Uganda Boundary Commission: E. G. Baker, Spencer Moore, and Dr. A. B. Rendle.

FRIDAY, FEBRUARY 17.

ROYAL INSTITUTION, at 9.—High Power Microscopy: John W. Gordon.

GEOLOGICAL SOCIETY, at 8.—Anniversary Meeting.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Protozoa in Relation to Disease: Prof. E. J. McWeeney.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.—Adjourned Discussion on the American Visit, 1904.—The Strength of Columns: Prof. W. E. Lilly.

MONDAY, FEBRUARY 20.

SOCIETY OF ARTS, at 8.—Internal Combustion Engines: Dugald Clerk.

VICTORIA INSTITUTE, at 4.30.—Biblical Astronomy: Lieut.-Colonel G. MacKinlay.

TUESDAY, FEBRUARY 21.

ROYAL INSTITUTION, at 5.—The Structure and Life of Animals: Prof. L. C. Miall, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Continuation of Discussion*:—Alfreton Second Tunnel: E. F. C. Trench.—The Reconstruction of Moncreiffe Tunnel: D. McLellan.—*Paper:* Surface-Condensing Plants, and the Value of the Vacuum Produced: R. W. Allen.

ZOOLOGICAL SOCIETY, at 8.30.

WEDNESDAY, FEBRUARY 22.

GEOLOGICAL SOCIETY, at 8.—On the Order of Succession of the Manx Slates in their Northern Half, and its Bearing on the Origin of the Schistose Breccia: Rev. J. F. Blake.—On the Wash-outs in the Middle Coal-measures of South Yorkshire: F. E. Middleton.

SOCIETY OF ARTS, at 8.—Some Misconceptions of Musical Pitch: John E. Borland.

THURSDAY, FEBRUARY 23.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On some New Species of Lagenostoma: a Type of Pteridospermous Seed from the Coal-measures: E. A. Newell Arber.—On a New Rhabdosphere: G. Murray, F.R.S.—On Changes observable in the Liver Cells during Digestion, and their Relation to Hepatic Secretion: Prof. E. Wace Carlier.—The Colour-Physiology of the Higher Crustacea. Part III.: F. Keeble and Dr. F. W. Gamble.—Phosphorescence caused by the Beta and Gamma Rays of Radium. Part II.—G. T. Beilby.

ROYAL INSTITUTION, at 5.—Recent Work of the Geological Survey: Prof. J. J. H. Teall, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Continuation of Discussion*:—The Value of Overhead Mains for Electric Distribution in the United Kingdom: G. L. Addenbrooke.

FRIDAY, FEBRUARY 24.

ROYAL INSTITUTION, at 9.—Fungi: Prof. H. Marshall Ward, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Curvature Method of teaching Geometrical Optics: Dr. C. V. Drysdale.—Exhibition of Dr. Meisling's Colour Patch Apparatus: R. J. Sowter.—A Method of illustrating the Laws of the Simple Pendulum, and an Exhibition of String Models of Optical Systems: J. Schofield.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Morecambe Sewerage: Method of Laying a 15-inch Cast-iron Sewer under the London and North-Western Railway: F. D. Flint.—The Reconstruction of Bow Bridge over the River Lea: H. M. Rootham.

SATURDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 3.—Archæology: D. G. Hogarth.

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