THURSDAY, OCTOBER 28, 1909.

THE CLEAVAGE OF THE OVUM.

Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere. Allgemeiner Theil, Dritte Lieferung. By Prof. E. Korschelt and Prof. K. Heider. Pp. 166. (Jena: Gustav Fischer, 1909.) Price 4.50 marks.

IN the development of the individual organism there are involved growth, cell-division, and differentiation. It is with the second of these that the present instalment of a splendid text-book deals.

Apart from certain alterations of egg-structure which are consequent upon fertilisation, the subdivision of its material is the first sign the fertilised ovum gives of its activity, and this "segmentation" proceeds with great regularity until other events—germ-layer formation—supervene. The problems that at once arise are therefore: (1) What is it which sets a term, not, indeed, to cell-division, for that continues, but to the period of segmentation? (2) To what causes must the definite pattern of division—spiral, radial, or bilateral, and so on—be attributed? and (3) Is there any necessary relation between the manner in which the ovum is thus cut up and the ultimate processes of differentiation?

In this volume—a very admirably written and beautifully illustrated description of the various types of cleavage—these problems are to some extent touched upon, and we are glad to see that the view is taken that it is the attainment of a definite size-relation between nucleus and cytoplasm which defines the end of this, the first phase of development (p. 7), though Boveri's important experiments are not noticed here.

In respect of the other two problems—which, indeed, largely overlap—the position which the authors appear to have adopted—that cleavage is necessarily a process of differentiation, that in some, *e.g.* in the spiral type, it is a "Mosaikarbeit" in Roux's sense, and that the blastomeres in this case are not interchangeable (pp. 15, 115)—is not, we believe, wholly justified by the results of experiment, though in dealing with the amphibian egg they admit (p. 38) that the relation between cell-division and differentiation is "wenig fixirt."

The truth is that Roux's attempt to demonstrate an absolute coincidence of the first furrow and the sagittal plane in the frog's egg, and the consequent formulation of the "Mosaik-theorie," with its imaginary qualitative division of the nucleus, still casts its shadow upon this discussion. That hypothesis, however, so far as the nucleus is concerned, has now been abandoned, while recent work has shown that the factors which determine the pattern of cleavage are distinct from the causes of differentiation, even in those cases in which cell-division does look like a "mosaic." Thus there is in the frog's egg a far closer relation between the plane of symmetry and the sagittal plane than between the latter and the first furrow. The type of segmentation may be altered, by pressure or other means, without prejudice to normal development. In the Ctenophora abstraction of the vegetative egg-substance involves absence of costæ in the embryo, but division is still normal, while the isolated *D. blastomere* of a Dentalium ovum will produce a normal larva, in spite of the fact that its cleavage is partial, because it contains the polar lobe. Moreover, cells occupying identical positions in similar cleavage systems have *not* always the same fate.

The two sets of factors may coincide, but they do not necessarily do so. The causes of cell-division will be found in the relations between nucleus and cytoplasm, surface tensions, and so on, of differentiation in the various substances present in the cytoplasm (and the nucleus), but the way in which this heterogeneous material is cut up in cleavage is a matter of indifference; what is essential is that it should be diminished by division until the necessary ratio between cytoplasm and nucleus has been reached.

A CANADIAN MINING AND METALLURGICAL DIRECTORY.

Report on the Mining and Metallurgical Industries of Canada, 1907–8. Pp. xvi+972. Canada, Dept. of Mines, Mines Branch. (Ottawa: Government Printing Bureau, 1908.) Price 1 dollar.

THE Dominion of Canada, having the area and varied geological and geographical structure of half a continent, has naturally a great diversity in its mineral wealth. The mining fields are widely scattered, and most of them are imperfectly known. Hence, in accordance with a wise provision of the Canadian Mining Act of 1907, a detailed guide to the mining and metallurgical industries of Canada has been prepared by the Department of Mines. The work has been prepared under the superintendence of the director, Dr. Haanel, and edited by Mr. S. Groves. In order to secure the most trustworthy and recent information, a series of special investigators have visited all the mining districts of the Dominion, and numerous short reports on the geology and on mining and metallurgical methods are included from members of the Geological Survey and from mining engineers. The work includes 936 pages of text, and is illustrated by numerous maps and plates, showing the distribution of the mining fields and views of the surface operations at the mines and metallurgical works.

The book is divided into two main sections, the first dealing with the metalliferous ores and fuels, and the second with building materials, cements, clays, ochre, &c. Each part is subdivided geographically; the history of mining in each province is recorded, and there is a brief, often, perhaps, too brief, statement of the structure of the mining field. The bulk of the work consists of an account of the present condition, including capital, staff, area, equipment, and operations, of every important mine and metallurgical establishment in the Dominion. This valuable directory of Canadian mining gives a clear idea of its growing importance and variety.

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In the far west, both in Yukon and in British Columbia, gold was the first attraction. The history of Yukon mining is summarised since the first report of gold there by Whymper in 1869. There is reference to the Klondyke boom in 1897–8, and the subsequent decline of the field. Lode mining there is still unimportant. Five dredges are at present mining the alluvial deposits, but they cannot work economically in frozen ground, which has to be thawed by the play of steam upon it.

In British Columbia gold mining began with the Fraser river rush of 1858, followed by twenty years of placer mining. Since 1887 lode mining has made steady progress; the gold is generally associated with copper, silver, or silver lead, and these ores have usually to be smelted. The most famous mining centre is Rossland, which includes some large copper deposits in which the unoxidised ore rises to the surface, and, according to Mr. Brock's account, some of these ores have been deposited parallel to the present land surface. The ores at Rossland occur in fissure veins in sheared and shattered belts, and as irregular impregnations of the country rock. The veins, such as that at Le Roi, the chief Rossland mine, are usually well defined. The ores are low-grade and their concentration is difficult, as the chalcopyrite which contains so much of the gold readily flows away in water.

Of the mines worked primarily for copper, the gold being obtained as a by-product, the most important in British Columbia is the Britannia Mine on Howe Sound, which consists of a mineralised belt of country up to 600 feet wide and two miles in length. Most of this rock contains only 0·5 per cent. of copper, and the ore of commercial value, containing an average of 1¾ per cent. of copper, occurs in large patches scattered through the mineralised belt.

The iron ores of British Columbia have hitherto been little used, but the Puget Sound Mine on Texada Island, a contact deposit between granite and limestone, and replacing both rocks along their junction, has been smelted with bog iron ores in San Francisco. The Glen Iron Mine, situated on the Canadian Pacific Railway, is worked to supply flux to the British Columbian smelters.

The most sensational story in recent Canadian mining history is that of cobalt, which was discovered by accident in 1903, and is famous for its narrow, rich veins of silver. They are found traversing ancient quartzites and conglomerates that have been intruded by diabase.

The Sudbury field is of great commercial, historical, and theoretical interest; it gives Canada the control of the world's nickel market, and has been the subject of a long controversy as to the origin of its ores. They are claimed by some authorities such as Prof. Coleman to be due to direct segregation from a molten rock, a norite gabbro; whereas other authors, relying on the microscopic structure and sequence of the minerals, claim that the ores were deposited long after the consolidation of the adjacent igneous rocks.

The volume contains a short account of Dr. Haanel's fruitful experiments at Sault Sainte Marie on the electric smelting of iron, and its maps give impressive evidence of the vast extent of the coal-fields of western Canada, as well as of the widespread and varied mineral wealth of the Dominion.

A MONUMENT TO LATIMER CLARK.

Catalogue of the Wheeler Gift of Books, Pamphlets, and Periodicals in the Library of the American Institute of Electrical Engineers. Edited by W. D. Weaver. With Introduction, Descriptive and Critical Notes by Dr. Potomian. Vol. i., pp. viii +504; vol. ii., pp. 475. (New York: American Institute of Electrical Engineers, 1909.)

ALL who knew Mr. Latimer Clark will feel the most lively satisfaction that his cherished and invaluable library of books ancient and modern relating to electricity should have found the resting-place and custodian which kind fate and American generosity have provided. The position is best expressed by the following three quotations from the book under review:—

"It was Mr. Clark's wish that this valuable collection of his should eventually be transferred to the United States, inasmuch as London was already in permanent possession of the Library of Sir Francis Ronalds. Failing an American purchaser, it was to go to Japan, 'a rising country which would greatly value such a unique collection.' Thus wrote Mr. Clark to Mr. P. Fleury Mottclay, of New York, on February 21, 1898, eight months before his death."

"My object in securing the collection was to present the books to our Institute and make it the custodian of the most complete electrical library in the world, as well as to stimulate such interest that the Institute may in time own a permanent home in New York."

"This work is due to the generosity of Mr. Andrew Carnegie, who donated a fund to house, catalogue, and complete the celebrated Latimer Clark collection of books, pamphlets, and periodicals presented to the library of the American Institute of Electrical Engineers by Dr. Schuyler Skaats Wheeler."

Given an unrivalled collection and a free hand, it is not every librarian or every professor of physics who could, in preparing what is called a catalogue, have produced what is in reality also a delightful book, which will afford the book-lover some of the inspiration and charm which the library itself alone can provide in full. The books are numbered in chronological order, the earliest being Vincentius (1190–1264). The system is to give a copy of the material on the title-page, with some account of the nature of the contents of the book. Where this is of exceptional importance, a facsimile of the frontispiece, title-page, or of some page or pages from the text, and of some illustrations is given also. On turning over the pages, the reader not altogether devoid of historical interest cannot fail to be attracted by these glimpses of the work of long ago, and to be driven to seek in the library itself the continuation of accounts of investigations to which the end of a page sets a disappointing limit. Among the facsimiles

is the historic letter, a typical example of the official *non possumus* attitude not even unknown at the present day, dated August 5, 1816, from the secretary of the Admiralty to Mr. (afterwards Sir) Francis Ronalds, F.R.S., relative to the electric telegraph.

"Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him with reference to his note of the 3rd inst. that telegraphs of any kind are now wholly unnecessary; and that no other than the one now in use will be adopted."

This was a semaphore!

The two volumes contain 5966 entries, and they are completed by a name-index.

The American Institute of Electrical Engineers is to be congratulated upon its possession of so valuable a library, the contents of which have been brought home to them in so pleasing and sympathetic a manner. C. V. BOYS.

COMPARATIVE ANATOMY OF ANIMALS.

An Introduction to the Study of the Comparative Anatomy of Animals. By Prof. Gilbert C. Bourne. Vol. i. Second edition, revised. Pp. xvi+299. (London: George Bell and Sons, 1909.) Price 6*s*.

PROF. BOURNE says rightly that there is a considerable difference of opinion as to the limits of elementary teaching in comparative anatomy, which he defines as "the science which treats of the architecture of animals." The second edition of his well-known and interesting text-book will be welcomed by all serious students of animal biology, for it is with animal biology rather than pure anatomy that it deals. This is necessarily the case, for anatomy and physiology must ever go hand in hand.

The position of biology in the University curriculum is at the present time a very critical one, especially in the case of medical students, for whom this work is expressly intended. The enormous increase in our knowledge of the detailed structure of all the commoner forms of animal life which has taken place during the last few years makes it more and more difficult to select the materials for a first year's course. The introduction of too large a number of types necessitates superficial treatment, while, on the other hand, the too detailed study of only a few types leaves the student without time to follow even the main steps in the evolution of the animal kingdom. He cannot see the wood for the trees. The chief value of the study of comparative anatomy and physiology for the medical student lies in the fact that they help him in the end to understand the structure and functions of the human body, but there is very much in the minute structure of the lower animals which is not necessary for this purpose, and we fear that the insistence upon what many regard as superfluous detail has done much in late years to discourage the study of zoology, not only amongst medical students, but also amongst others who doubt their ability to digest and assimilate (especially for examination purposes) the immense mass of intellectual food set before them. Fortunately so much detail, however interesting in itself, is not really necessary for the comprehension of the great principles of the subject.

Prof. Bourne's view is, as he tells us in his preface, that the more elementary the teaching the fuller it should be, and this view finds full expression in the volume before us, which, we venture to think, is likely to appeal to the advanced perhaps even more than to the elementary student. Protozoa are fashionable at the present day, but it is, perhaps, a pity that Prof. Bourne did not follow what he tells us was his original intention, and omit some of the types with which he deals so fully. Actinosphærium, at any rate, has very slight claims to inclusion in an elementary text-book. On the other hand, a cordial welcome may be extended to Copromonas, a very valuable new type, of which an admirable account is given, based upon the work of Mr. Dobell.

A few inaccuracies in phraseology might with advantage be attended to in future editions, *e.g.* "smell and taste are localised patches of end organs" (p. 9), but these are minor blemishes which detract but little from the thoroughness with which the author has carried out his extremely useful work.

MODERN MIRACLES.

The Faith and Works of Christian Science. By the writer of "Confessio Medici." Pp. xi+242. (London: Macmillan and Co., Ltd., 1909.) Price 3*s*. 6*d*. net.

THE cult, if it may be so termed, of Christian science has taken considerable hold on a section of the community here and elsewhere, and we welcome this book by the author of "Confessio Medici" exposing its fallacies, inconsistencies, and dangers. No one, perhaps, could do this in a more genial manner, but the whole forms a scathing indictment indeed.

In the introductory pages the author tries with more or less success to put into plain words the contrast between philosophy and Christian science. He then arranges in the form of articles some of the tenets of Christian science taken from Mrs. Eddy's writings, discusses life and Christian science, the reality of disease and the reality of pain, and gives a brief survey of Mrs. Eddy's remarkable career. Next, and most important, the record of the testimonies of healing by Christian science is critically examined. Two hundred recent cases (April–August, 1908) are analysed; the author has taken the trouble to write to many of the patients for additional information, and a more inadequate and unconvincing series could hardly be imagined. This one is healed of "kidney and liver trouble," that one of "stomach trouble," a third of "fever," a fourth of "colds and eruptive fever," and so on. The details are of the scantiest, and, in most instances, the diagnosis is the patient's own. The author concludes from these evidences

"that Christian science accepts all testimonials, even the most fantastic and illiterate. That she embellishes what she publishes. That she evades investigation. That her claim to cure organic disease

breaks down under the most elementary rules of criticism. That she does cure 'functional' diseases. That she has never cured, nor ever will, any disease, except those which have been cured, a hundred thousand times, by 'mental therapeutics.'"

Two further lines of criticism are pursued by the author. First, he pictures a large hospital given over to the care of Christian "scientists," with its cases of appendix abscess rupturing into the peritoneum, strangulated hernia going on to gangrene, advanced heart disease getting out of bed and taking violent exercise, and spinal disease hanging on gymnastic bars! Secondly, he has obtained information from various medical practitioners of cases of organic disease going from bad to worse under the "treatment" of Christian "scientists."

The author is no dogmatist; he freely admits the influence of mind over body, that Christian science may cure hysteria and the liquor habit, that as regards the revival of "spiritual healing" it is for the patient and the family to have what ordinance or ritual they wish to have. No doctor would find fault with that sort of work provided it is kept in its proper place. This aspect of mind renders the book all the more convincing, and we feel sure that it may fill a useful place in refuting the pretensions of Christian "scientists." R. T. H.

SEMITIC MAGIC.

Semitic Magic, its Origins and Development. By R. Campbell Thompson. Pp. lxviii+286. (London: Luzac and Co., 1908.) Price 10*s.* 6*d.* net.

MESSRS. LUZAC have produced a useful as well as well-looking volume as the third contribution to their "Oriental Religious Series" in Mr. R. Campbell Thompson's "Semitic Magic." Mr. Thompson's book is an attempt to bring our knowledge of Arab, Hebrew, and Babylonian (Assyrian) magic into line with the scientific treatment of the demonology and witchcraft of other peoples which the labours of many devoted workers have given us during the past half-century.

It is not too much to say that the field of Semitic magic has hitherto been somewhat unduly neglected by writers on the subject. Probably shyness of dealing with a subject which must owe so much to a correct interpretation of the cuneiform texts has had much to do with this fact. A knowledge of the necromantic ideas of the Jews and the Arabs, especially of those of the former people, we have always possessed in abundance, but Semitic magic without Babylonian and Assyrian magic would indeed be Hamlet without the Prince of Denmark, and up to the present time general anthropologists have rightly been diffident of their power to collate adequately material of which they have no first-hand knowledge with the results of their study of the necromancy of the Jews and Arabs. It was first necessary that a cuneiform scholar should be found with an active interest in the general subject, and a competent knowledge of the other anthropological material, not only from the rest of the Semitic nations, but from the whole of the primitive world.

Mr. Thompson, who is an Assyriologist with a general knowledge of anthropology and a special interest in the subject of magic, has essayed to fill the gap; and we think that as a first essay he has done so very successfully. His book is not an exhaustive treatise; it can be regarded simply as an introduction to the subject, based from the Semitic side ultimately on Robertson Smith's epoch-making book, "The Religion of the Semites," and from the general side largely on the work of Frazer. But at the same time, Mr. Thompson is an original thinker who does not hesitate to criticise the work of his models when he thinks they are wrong, and to draw new conclusions from the large amount of new material which he now places in our hands, derived from his own Assyriological knowledge. Later on Mr. Thompson may perhaps produce a larger work on the subject, to which his present volume will serve as a preface. As it stands, his book is an authoritative contribution to anthropology, which will be found of very great use by all students of the beliefs of primitive mankind.

Mr. Thompson lays great stress upon the subject of tabu, of the existence of which he finds constant evidence among the Semites, while demoniac possession, sympathetic magic, and the specially Semitic ideas of the Atonement, Sacrifice, and the Redemption of the Firstborn, all have chapters specially devoted to them. The long quotations which he gives from the cuneiform texts are of great interest, and enable us to form an adequate idea of the great part which magic played in the daily life of the oldest civilised peoples of the ancient world.

OUR BOOK SHELF.

British Rainfall, 1908. *On the Distribution of Rain in Space and Time over the British Isles during the Year* 1908 *as recorded by more than* 4500 *Observers in Great Britain and Ireland, and discussed with Articles upon Various Branches of Rainfall Work.* By Dr. Hugh Robert Mill. Pp. 100+304; with maps and illustrations. (London: Edward Stanford, 1909.) Price 10*s.*

THE author has stated elsewhere that the perfect rainfall map is a thing of the future, many preliminary studies being necessary before it can be drawn. The irregularity of rainfall and its dependence upon orographical features require a very large number of stations, and observations made during the same period for at least thirty or thirty-five years for determining its average annual distribution and variation. By the energy of the late Mr. G. J. Symons, the founder of the British Rainfall Organisation, and his successors, the British Isles can boast of a system of rainfall observations quite unique and unrivalled by that of any other country; the data published yearly in "British Rainfall" supply invaluable materials for general discussions, and, in fact, have been frequently utilised by various authorities. Part i. of the present volume, the forty-eighth of the series, contains articles by Dr. Mill on new recording rain-gauges, by Mr. A. Lockwood on rainfall observations in Snowdonia, and others; also records of evaporation and percolation, duration of rainfall at various stations, and other matter. Part ii. includes, *inter alia*, observers' weather notes for days, months, and the year, heavy rains for short periods and for days, monthly and

seasonal rainfall, and a general table of the annual rainfall at all stations. There is also a coloured frontispiece map showing the relation of the rainfall of 1908 to the average of 1870–99. The rainfall of Scotland and Ireland, generally, was practically normal, that of England and Wales rather more than one-tenth less than the average. Only a small part of England and Wales, but a large part of Scotland and Ireland, had more than the average; parts of the south of Ireland, south-west and east of England and east of Scotland were very dry. The greatest annual amount recorded was 237·3 inches, at Llyn Llydaw (Snowdon); the least, 15·6 inches, at Bourne (Lincolnshire). Among the changes introduced in this volume may be mentioned (1) that, in discussing monthly rainfall, maps of the actual fall are given side by side with those showing the percentage difference from the normal; (2) much fuller treatment of the sections relating to heavy falls on rainfall days and in short periods. Although efforts have been made to economise space, and no part is a repetition of any previous issue, the present volume is larger than any of its predecessors, and, we think, compares favourably with them.

La Mesure rapide des Bases géodésiques. By J. René Benoit and Ch. Ed. Guillaume. Quatrième édition. Pp. 228. (Paris: Gauthier-Villars, 1908.)

THE invention of invar, the nickel-steel alloy with a small or zero coefficient of expansion, in 1897 imported new conditions into determinations of length. The great value of this invention for the measurement on the ground of the base-lines of a survey was at once apparent, and during the next year the new method was tried by the joint Russo-Swedish expedition in Spitsbergen. The results obtained equalled the most sanguine expectations. Not only was a high limit of precision attained, but the rapidity of the work, as compared with the old methods, was enormously enhanced. It was obvious that the geodesist had in his hands a new tool which greatly accelerated the most laborious portion of his operations, and at the same time gave him a degree of accuracy at least equal to that hitherto achieved with far more cumbrous apparatus.

These results came into prominent notice at the International Geodetic Conference held at Paris in 1900, and a further and more minute investigation of the whole problem was undertaken by the Comité international des Poids et Mesures.

At the meeting in 1905 a report was furnished by the present authors, to be expanded into a more complete form for presentation to the Geodetic Conference of 1906. The large demand for copies of this report, and the fact that the new method has now been adopted by almost all surveys having any pretensions to execute work of the first order, have induced the authors to put the record of their investigations into a permanent and convenient shape. Of the present little volume we can only say that it is one that must be in the hands of every geodesist. It contains, in a succinct form, the general theory of measurements by wires hung freely between supports, a short discussion of the physical properties of invar, an account of the testing and standardisation of the wires and of their possible distortions under different conditions of tension, temperature, repeated windings and unwindings, and, in general, their stability under the practical conditions of their employment in the field. This is followed by a description of the auxiliary apparatus used for base measurement, all of a very simple character, and a full account of the routine of the field work and of the calculations for the reduction of the measures to the horizontal, including the necessary tables.

A summary of the actual results attained in practice shows that a rate of measurement of about 5 kilometres per day can be kept up with a limiting error of between $\frac{1}{500000}$ and $\frac{1}{1000000}$. With special precautions a still higher degree of apparent accuracy can be reached, but such appearance is largely delusive, and in geodetic work would soon disappear in the angular measures.

We congratulate the authors, not only on their most valuable investigations, but also upon the excellent form in which their conclusions are presented.

E. H. H.

Bibliotheca Geographica. Jahresbibliographie der gesamten geographischen Literatur. Herausgegeben von der Gesellschaft für Erdkunde zu Berlin. Bearbeitet von O. Baschin. Band xiv. Jahrgang, 1905. Pp. xvi+545. (Berlin: W. H. Kühl, 1909.)

THIS is one of those publications (and there are not a few) for which British geographers may well be grateful to German. We do not produce many works of this kind—works which can hardly bring profit sufficient to reward the labour of their compilation. The "Bibliotheca Geographica" is a wonderfully full bibliography of geographical books and papers published, in all parts of the world, during the year 1905—it is not to be wondered that the volume bears a date of issue four years later, when the magnitude of the task of tracing such a vast number of publications is considered. General treatises on the various scientific branches of geography are given first; after these there follows what occupies the bulk of the volume—a bibliography according to topographical divisions. Each topographical division is minutely subdivided according to special subjects, an arrangement which partially disarms the criticism that the entry of a publication under its own title or the name of its author seems somewhat arbitrary.

It is doubtful, however, whether any large bibliography would entirely escape this criticism. Some difficulty, again, is evidently felt with regard to the entry of individual papers out of collected volumes. Thus, when the report of a research committee of the British Association is entered only under the name of the secretary of the committee, it may be doubted whether this method gives the reader the best chance of finding the reference. On the other hand, cross-references are provided from one subject subdivision to others of a kindred nature, and at the end there is an authors' index, so that one cannot but recognise that the system of the whole work is well-nigh perfect. Moreover, the entries, so far as can be judged, appear to be admirably accurate.

The Invicta Number Scheme. By J. W. Ladner. (London: George Philip and Son, Ltd., n.d.) Handbook, price 8*d.* net; Number Board, price, with plain edges, 6*s.* 6*d.* per dozen; with edges, cloth-mounted, 8*s.* 6*d.* per dozen.

THIS device is a method found useful by a practical schoolmaster of experience in teaching the fundamental principles of arithmetic by constant reference to the decimal system of notation. The plan utilises not only the ears, but the hands and eyes of the children. Though many original teachers will have developed equally good expedients for rendering their lessons in arithmetic practical, interesting, and intelligible, the scheme may be recommended to the attention of teachers who have not as yet adopted concrete aids in their instruction. It is now very generally agreed that children learn best by doing, and Mr. Ladner's method of teaching will certainly assist the children to arrive at the rules they have to learn from the results of their own experiments.

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.]*

Magnetic Storms.

IN his article upon the recent magnetic storm (NATURE, September 30) Dr. Chree writes:—"Another difficulty in regarding the phenomena of magnetic storms as entirely and directly due to the action of electrical currents associated with aurora is that it is a frequent occurrence—as on the present occasion—for the horizontal force to be considerably depressed below the normal value when the storm has apparently ceased and for some considerable time thereafter. It is possible, of course, that the external currents have partly demagnetised the earth, or at least modified its distribution of magnetism, and that there are recuperative tendencies tending to cause reversion of what is for the time being a more stable distribution, but if this be the true explanation the demagnetising action and the recuperative tendencies are presumably in action during the course of the storm, and profoundly modify the magnetic phenomena."

I wish to add to Dr. Chree's words the remark that this phenomenon of decrease in horizontal intensity is nothing but part of the phenomena I described a long time ago,[1] and about which I exchanged opinions with Dr. Chree in *Terrestrial Magnetism*.

Later on I found occasion in several publications again to deal with those phenomena of "Post-turbation"; also recently, at the meeting of the Helvetic Association of Natural Science at Lausanne.

In a short statement I directed attention to the fact that the results of my investigations on magnetic perturbation are in accordance with the splendid results and theories of Birkeland and Størmer.

My results were shortly as follows:—

A force of disturbance is always present; it strongly increases when a storm appears, decreasing afterwards. The horizontal component of this force is chiefly directed to the magnetic south, *i.e.* along the meridian of the regular magnetism of the globe, thus lying in the plane through the magnetic axis and the station.

The vertical component, on the contrary, mostly has the same direction as that of permanent magnetism, *i.e.* downward in the northern hemisphere. Its character and sign are much less constant than those of the horizontal component.

The regular post-turbation is most frequent at lower latitudes.

An extensive study of all the storms recorded at Batavia has taught me that the post-turbation often emerges in a negative sense (northerly), but shortly after turns and reaches its maximum positive value. Afterwards it decreases at a slower rate, and this decrease continues until a new storm (it may be a very small one) appears. I found that successive quiet days show that same decrease. This is the same that Dr. Chree also detected, and called non-cyclic variation.

At Lausanne I pointed to the fact that this kind of disturbance corresponds to Birkeland's class of positive equatorial disturbances. He also found negative disturbances, but from my statistics it is evident that they are much less frequent than the positive.

As to the cause of these positive equatorial disturbances, Birkeland, according to his experiments with his terella and the theoretical calculations of Størmer, accepts currents of electrons flying around the magnetic equator of the earth. As for the negative ones, he accepts electrons which move also in that plane, but through a loop in their orbit, thus having a contrary direction.

If we accept the cause of the post-turbation to be the presence of an electric current, this current must be extra-terrestrial, because the vertical component generally increases when the horizontal one decreases.

The less regular character of the vertical component may be explained by the currents of induction raised inside the globe. Accordingly, an effect of demagnetisation of the earth seems to be improbable.

From the inspection of thousands of magnetic curves recorded at Utrecht, Batavia, and other non-Arctic stations, I received the impression that the increase and decrease of the post-turbation are fairly regular, the rapid oscillations being superposed on this variation.

No doubt these rapid oscillations are caused by currents of electrons nearly approaching the earth, and this will happen more frequently in the polar regions than in the equatorial ones. Thus the action of the ring current will show itself more distinctly at stations at lower latitudes, the ring being nearer to them than to stations at higher latitudes, and it will be less disturbed by other currents coming very near to the earth.

Dr. Chree concludes his article with wise words, saying:—"To many minds subscription to some theory may be a necessity for intellectual comfort, but in the case of magnetic storms reservation of judgment appears at present the more scientific attitude."

I fully agree with him in this respect, but I think he, who himself has contributed so much to the science of terrestrial magnetism, will agree with the call for more activity. The work of Birkeland and Størmer is splendid indeed, but it is only in the power of international cooperation, such as in the year 1882–3, to unravel all the problems of magnetic disturbance.

We should repeat that work, considering that at present we are able to do so much better and more completely than our predecessors were in those days.

Concentration of our efforts on special problems, I think, would be more effective than the unsystematic accumulation of material nowadays.

The crowding of permanent magnetic observatories in Europe may be favourable to the solution of minor problems; it is a hindrance to that of the fundamental ones, because it absorbs too great a part of the powers at our disposal.

W. VAN BEMMELEN.

The Hague, October 13.

[1] "Die magnetische Nachstörung," *Meteorologische Zeitschrift*, 1895.

Homogeneous Corpuscular Radiation.

WHEN a metal plate is subjected to a beam of Röntgen rays, a corpuscular radiation is in general emitted, in addition to the secondary radiation of the Röntgen type.

This corpuscular radiation has been investigated by various experimenters. They have shown that the intensity and the absorbability of this radiation vary when different metals are used, and that they are also dependent upon the degree of "hardness" of the exciting radiation. In particular, Cooksey has recently shown that the corpuscular radiation excited by a "hard" primary beam is homogeneous, while that excited by a "soft" primary is heterogeneous.

But the primary beams used in these investigations were necessarily heterogeneous, and it is therefore impossible to decide with certainty which components were chiefly concerned in producing the phenomena under investigation.

It has been shown in various papers by Prof. Barkla and myself that a series of secondary Röntgen radiations can be obtained from the group of metals the atomic weights of which lie between those of chromium and silver, each radiation being homogeneous and having a perfectly definite coefficient of absorption by a given metal, *e.g.* aluminium. The absorption coefficients of the beams from the different members of the series vary greatly in value; thus for the secondary radiation from iron the absorption coefficient by aluminium is 240, while for that from silver it is only 6·7.

I wish to place on record a summary of the results of some investigations I have made upon the corpuscular radiations excited in various metals when these homogeneous secondary beams are employed as primaries instead of the heterogeneous primary beams used by previous investigators.

(1) It had been shown by Prof. Barkla and myself that the penetrating power of the incident primary radiation must exceed that of the homogeneous secondary Röntgen radiation characteristic of a metal before the latter is excited. Using homogeneous beams, I have shown that when the primary beam is only just more penetrating than the secondary Röntgen radiation characteristic of the metal, the intensity of both the secondary Röntgen radiation and

the corpuscular radiation is small. For a slightly more penetrating primary beam a rapid increase in the intensity of both the secondary Röntgen radiation and the corpuscular radiation takes place. This seems to suggest that the production of corpuscular radiation is in some way intimately associated with the emission of the Röntgen type of radiation.

(2) I had recently shown that when homogeneous radiation falls upon a thin layer of a substance which may act as a secondary radiator, a portion is transmitted unchanged, and that the fraction of the remaining energy which is transformed into secondary Röntgen radiation *decreases* as the primary beam becomes more penetrating. In the present experiments it is found that the corresponding fraction of the remaining energy which is transformed into corpuscular radiation *increases* as the primary beam becomes more penetrating.

(3) The corpuscular radiation emitted by these metals when subjected to homogeneous beams is itself surprisingly homogeneous, whether the exciting beams are "soft" or very "hard."

(4) The absorption coefficients of the corpuscular radiation from a given metal excited by homogeneous secondary Röntgen radiation vary with the nature of the exciting radiation. These absorption coefficients are a decreasing linear function of the atomic weight of the secondary radiator.

I hope to publish further details of these experiments shortly.

CHARLES A. SADLER.
George Holt Physics Laboratory,
Liverpool University.

Drought in South-west Ireland.

THE deficiency of rainfall in the south of Ireland, to which Mr. Armstrong refers in NATURE of October 21 (p. 487), has been apparent in the annual total rainfall for the last three years, the deficiency also affecting the south-west of England. At the same time, there has been a marked excess of rainfall in the north of Ireland, deficiency and excess being taken as synonymous with quantities below and above the average of many years. It is frequently found that parts of the country, often quite narrow strips, show a marked deficiency of rainfall for several successive years, and afterwards revert to an average condition or show an excess. The most probable explanation seems to me to be a change, perhaps a slight one, in the prevailing tracks of the centres of barometric minima, but I have not found data in a form suitable for testing the truth of the suggestion.

The extreme dryness of August was experienced over a large area of the south of Ireland, less than half an inch of rain having fallen over about 2800 square miles. In September less than half an inch fell over not more than 500 square miles.

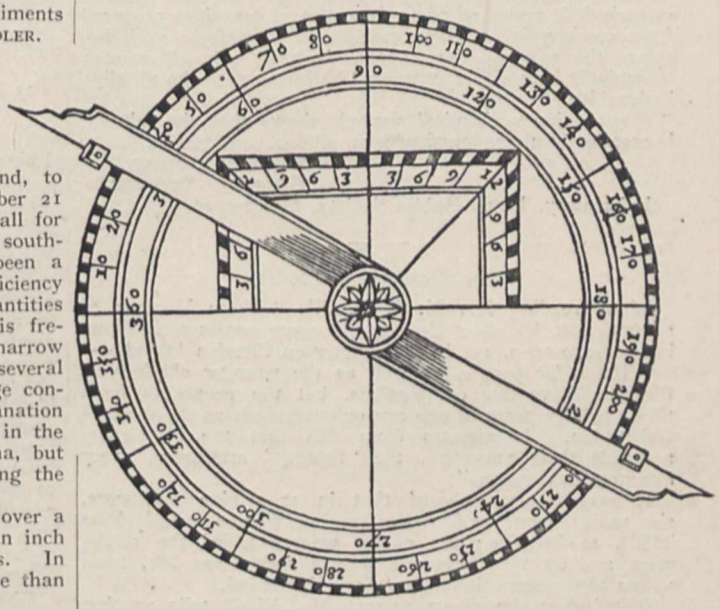
I may perhaps be excused for pointing out that while Mr. Armstrong uses "absolute drought" to describe a period of twenty-four hours without rain, it has been usual for many years to reserve the words "absolute drought" for a period of more than fourteen *consecutive* days without recorded rainfall.

HUGH ROBERT MILL.
62 Camden Square, London, N.W., October 25.

Derivation of the Word "Theodolite."

ALTHOUGH the etymology of the word theodolite has been discussed from time to time,[1] no satisfactory solution has hitherto been established. It was first used in England, and the earliest reference to it is contained in a book by Leonard Digges (completed and published by his son, Thomas) called "Geometrical practical treatize, named Pantometria, diuided into three bookes, longimetria, planimetria, and stereometria, &c.," first published in 1571, with a second edition in 1591, wherein the "composition of the instrument called Theodelitus" is represented as a "circle diuided in 360 grades or degrees, or a semi-circle parted in 180 portions"; or again, "the composition also of the Square and Planisphere or Circle named Theodelitus for measuring lengthes, breadths, and distances." It had a "*double scale*," an "index," "the sightes," and the circle was 2 feet in diameter, and "fastened in the top of some staffe." He does not state how the name was derived, and spells it "theodelitus" and "theodolitus" alternately. William Bourne ("Treasure for Travailers," 1578) named the same instrument "horizontall or flatte sphere," and not theodelitus; but when he speaks of the alidade he calls it only once *alideday*, but otherwise always *athelida*. After this de Morgan, who first discussed the derivation in the *Philosophical Magazine*, concluded that the "theodelited circle" of Digges, who, however, does not use that adjective, and "athelidated circle" of Bourne, were various corruptions of the Arabic word *al-idhâda* (a sort of rule), from which the word *alidade*, which carries the sights or telescope of a theodolite, is derived.

It has been suggested by various writers that theodolite is derived from the Greek roots θέα (sight), ὁδός (the way), and λίθος (a stone), for the latter root λῑτός (smooth) being



Reproduction of Digges' illustration of his "Theodelitus." From the *Zeitschrift für Vermessungswesen.*

substituted by others; also from θεάω (I see) and δολῑχός (long). Another suggested derivation is the English article "*the*" combined with the Arabic "*alidhada.*"

In searching for a more satisfactory solution, the idea occurred to the writer that the word would naturally be compounded to represent the principal parts of the instrument, and when reading Prof. E. Hammer's latest and most interesting discussion in the *Zeitschrift für Vermessungswesen*, vol. xxxvii. (1908), pp. 81–91 and 113–25, he was impressed by one of the illustrations reproduced of Digges' "theodolitus" and description of it, with special mention of the words "sightes," "index," and "double scale." He would submit, therefore, that the true etymology is from the Greek words θέᾱ=a sight; ὁδελός= any pointed instrument; ἴτυς=a circle or a felloe of a wheel. These Greek words appear to be those which would actually denote the three essential parts of the instrument, viz. the *sight*, the *index arm*, or alidade (Digges uses the word index, never alidade), which is represented as a pointed instrument, and the limb of graduated *circle*. The spaces on the circle appear like the

[1] *Philosophical Magazine*, vol. xxviii. (1846), note by de Morgan, pp. 287–9. *Poggendorff's Annalen*, vol. cxxxiii. (1868), pp. 192, 349. *Zeitschrift für Vermessungswesen* (1880), p. 55; (1883), p. 321; (1908), pp. 81–91 and 113–25. Vogler's *Praktische Geometrie* (1884), p. 361. *Proc. Inst. C.E.*, vol. clxxiii. (1907–8), p. 339. *Preussische Jahrbücher*, note by Prof. Didolff, vol. cxvi. (1904), pp. 362–4.

felloes of a wheel. This derivation corresponds with Digges' description of the instrument.

E. H. V. MELVILL.

203 and 204 New Stock Exchange Buildings,
Johannesburg, Transvaal, September 27.

A Supposed New Mineral.

A SPECIMEN of a mineral, forming portion of a mass stated to have been found in the basalt of Co. Antrim, was recently sent for identification to the office of the Geological Survey of Ireland by Mr. S. B. Wilkinson, the senior geologist, to whom it was handed by the finder. As it presents some peculiar features, and appears to be new to science, we take this opportunity of recording its occurrence. The complete examination of the mineral will necessarily occupy some time.

The mineral strongly resembles cobaltite in appearance. Its lustre is metallic, hardness about six. It breaks with a surface which under the microscope shows a finely conchoidal structure. When etched with an acid a crystalline structure becomes apparent; it is fusible with difficulty, but in the oxyhydrogen flame it melts without apparent alteration. Heated in a closed tube it does not yield any sublimate.

When the mineral is powdered, or even its surface scratched, it emits an odour like that of acetylene prepared from commercial calcium carbide. Hydrofluoric acid dissolves the mineral, the other acids have little effect upon it, while it is readily decomposed by fusion with the alkaline hydroxides.

A preliminary chemical analysis shows that the mineral is essentially a compound of iron, silicon, and carbon.

RICHARD J. MOSS.
HENRY J. SEYMOUR.

Laboratory, Royal Dublin Society, October 20.

The Pitcairn Islanders.

WHEN reading Mr. M. J. Nicoll's "Three Voyages of a Naturalist" a short time ago, I came across the following passage on p. 211 in the chapter on Pitcairn Island:—

"The older people, as well as the younger children of Pitcairn, have fair complexions, but the people of from thirty to fifty years of age are quite as dark as the average Polynesian. It appears from this that the Pitcairners resemble their ancestors, the 'Bounty' mutineers, every alternate generation."

It may be remembered that in 1790 nine mutineers, six native men, and twelve native women sailed from Tahiti to Pitcairn; the native women killed the native men, and by 1800 only one British sailor was left, from whom the present inhabitants are descended.

Just before the above extract Mr. Nicoll tells us that "Lord Crawford paid a visit to the two oldest inhabitants . . . both of whom are grandchildren of the original mutineers." So we see that the grandchildren and the great-great-grandchildren were fair, resembling the British men, while the great-grandchildren were dark, resembling the native women. That is to say, that F_2 and F_4 generations resembled the ♂ P_1, while F_3 generation resembled the ♀ P_1.

These facts struck me as being particularly interesting, as experiments of this nature in human heredity are difficult to obtain. Perhaps some "Mendelist" may be able to use or explain them.

C. B. WILLIAMS.

Clare College, Cambridge, October 14.

The Auroral Display of October 18.

I WAS very much interested in Mr. Harcourt-Bath's letter describing an auroral display which he saw from the Cotteswold Hills.

From West Kirby Hill, on the Wirral, I noticed a luminous band low down on the horizon, with upward streamers and "a detached, red, cloud-like portion" rather north of west.

What struck my attention, however, was that behind this red patch there were dark clouds, at no great altitude, faintly illuminated on the underside by the aurora.

As the red colour outlasted the streamers by several minutes, I was brought to the conclusion that it was independent of the auroral display.

However, in view of Mr. Harcourt-Bath's letter, I am led to ask you if observers have ever thought that an aurora could be comparatively close to the earth, and not of necessity in the "highly rarefied layers of the air"?

ERNEST J. BATY.

"Nunclose," West Kirby, Cheshire.

IT may interest Mr. Harcourt-Bath to know that the auroral display of October 18 was strikingly visible at Dudley. At 9.15 p.m. there were six or more broad beams of white light of unequal lengths and widths. These sprang normally from a broad circular arc resembling a "Milky Way" in luminosity and a broad rainbow in shape and size.

The central vertical beam was the brightest, widest, and longest, extending vertically about 45°, but not terminating definitely; it was about 10° W. of N.

The broad arched base appeared to cross through Ursa Major, the vertex being about 20° above the horizon, and was not uniformly bright. About 9.30 p.m. the left-hand (W. of N.) half of the base became a soft violet light; the right-hand portion remained white, but grew fainter.

W. AUSTIN MORLEY.

14 Park Road, Dudley, October 26.

The Occurrence in India of the Pappataci Fly (*Phlebotomus papatasii*).

THE *rôle* nowadays assigned to *Phlebotomus papatasii* in the transmission of a certain type of fever (see "Das Pappatacifieber," 1909, by Drs. Doerr, Franz and Taussig) makes the geographical distribution of this little fly a matter of practical importance. It is therefore interesting to note that this species is common in certain parts of northern India. Some time ago Mr. F. M. Howlett, second imperial entomologist, sent me specimens from Rawalpindi, in the Punjab, and Pusa, in Bihar, which I identified as belonging to a species allied to *P. papatasii*. Through the kindness of Dr. J. H. Ashworth I have now been able to compare some of these specimens with European examples of *P. papatasii* in the zoological laboratory of the University of Edinburgh. I can find no difference except that the Indian specimens are perhaps slightly smaller than the European ones. The former agree as regards venation, genitalia, &c., with Grassi's beautiful figures ("Ricerche sui Flebotomi," 1907).

In addition to *P. papatasii*, six Indian species of Phlebotomus are now represented in the collection of the Indian Museum. They will be fully described shortly.

N. ANNANDALE.

The Mansfield Automatic Water-finder.

WITH reference to Mr. A. A. Campbell Swinton's letter in regard to Mansfield's water-finder, which appears in NATURE of October 14, it may be of interest to state that I made inquiries from Messrs. Mansfield and Co. in May, 1908, asking for the names of the "leading scientists and engineers" who, as they stated, "vouched for the successful application of the invention"; they did not send me any names, but allowed a friend of mine in Liverpool to call to see the documents. One was from an architect in Liverpool, another from a firm of well-borers, and there were some foreign ones, but none were produced that were signed by persons whom I should describe as "leading scientists and engineers."

I may add that I expressed my willingness to test their instrument, but one was not placed at my disposal.

J. WERTHEIMER.

Merchant Venturers' Technical College, Bristol,
October 20.

TO DETERMINE THE REFRACTIVITY OF GASES AVAILABLE ONLY IN MINUTE QUANTITIES.

ON a former occasion[1] I described a refractometer capable of dealing with rather small quantities (12 c.c.) of gas. The optical tubes, one of which would contain the material under investigation and the other air, were of brass, 20 cm. in length and 6 mm. in bore, and were traversed by two pencils of light from the same origin, subsequently brought to interference in the observing telescope. For this purpose the object-glass of the telescope was provided with two parallel slits opposite the axes of the tubes. The image of the original slit, formed in the focal plane, was examined through a high-power cylindrical lens, constituting the eye-piece of the telescope, and exhibited the familiar pattern of interference bands the position of which shifts with changes in the densities of the gases occupying the tubes. With this apparatus, and using pressures not exceeding one atmosphere, it was possible to compare refractivities $(\mu - 1)$ with a relative accuracy of about one-thousandth part.

In recent conversation my son, the Hon. R. J. Strutt, raised the question as to the minimum quantity of gas upon which a determination of refractivity could be made, having in mind such rare gases as the radium emanation. Towards answering it I have made a few experiments dealing merely with the optical side of the question.

A reduction of volume in the gas tube implies a reduction of length below the 20 cm. of the apparatus just referred to, and this carries with it a loss of accuracy. A reduction to 2 cm. should leave possible an accuracy of at least 1 per cent., and this was the length chosen. As the inquiry was limited to the optical conditions, it was unnecessary to close the ends, and thus the tubes reduced themselves to two parallel tunnels through a block of paraffin 2 cm. thick. They were prepared by casting wax (from a candle) round two similar sewing needles of suitable diameter previously secured in a parallel position. The rest of the apparatus was merely an ordinary spectroscope arrangement (without prism). Sunlight admitted through a slit, and rendered parallel by the collimating lens, traversed the double tunnel, and was received by the observing telescope focussed, as usual, upon the slit. It is necessary, of course, that the length of the slit be perpendicular to the plane containing the axes of the tunnels.

The appearance of the bands as seen with a given telescope depends upon the size of the apertures and upon their distance apart. The width of the bands is inversely as the distance between the centres of the apertures (tunnels), and the horizontal diameter of the luminous field upon which the bands are seen is inversely as the diameter of the apertures themselves. Since a large number of bands is not required, small and rather close apertures are indicated. The only question is as to the amount of light. If we suppose the apertures and their distance apart to be proportional, we may inquire as to the effect of linear scale L. Here a good deal may depend upon the relative values of length of slit, focal length of collimator, length as well as diameter of tunnels. In my apparatus the slit was short, and the height, as well as the width of the field of view, was determined mainly by diffraction. If we suppose the slit very short, the calculation is simplified, though this cannot be the most favourable arrangement. With a given width of slit the whole light in the field of view is then proportional to L^2. Since the angular area of the field practically varies as L^{-2}, it would seem that the brightness varies as L^4. This would impose an early limit upon the reduction of L; but there are other factors to be regarded. In order to secure an angular field of given size, we must use an eye-piece the magnifying power of which is proportional to L. This consideration changes L^4 back to L^2. Nor is this all. With a given eye-piece the admissible width of primary slit varies inversely as L, and thus, finally, the brightness of a field of given angular width, and containing a given number of bands, varies as L simply.

In the earlier experiments the tunnels were of $\frac{3}{4}$ mm. bore, and were too widely separated. In order to see the bands well, a very powerful eye-piece was needed. An attempt to gain light by substituting a cylindrical lens (very successful in the former apparatus, where the beams are limited by *slits*) for the spherical lenses of the eye-piece showed little advantage. Subsequently smaller tunnels were prepared $\frac{1}{2}$ mm. in bore, and so close that the distance of the nearest parts was rather less than the diameter of either. These gave splendid bands with the ordinary eye-piece of the spectroscope, and I estimated that there should be no difficulty in setting a web correctly to one-twentieth of a band.

The capacity of one of these passages is about 4 cubic millimetres, and I have no doubt a further reduction might be effected, so far as the optics is concerned; but the further such reduction is carried the greater, probably, would become the difficulties of manipulation. The mere closing of the ends of such small tubes with plates of glass would not be an easy matter. In order to prevent encroachment upon the course of the light, it might be necessary to enlarge the ends so as to allow a little more room for overflow of cement. For the present I content myself with showing that it is possible to obtain well-formed black bands on a sufficient angular scale with light which has traversed tubes 2 cm. long and $\frac{1}{2}$ mm. in bore.

RAYLEIGH.

[1] Proc. Roy. Soc., vol. lxiv., p. 95, 1898; Scientific Papers, iv., p. 364.

GAY-LUSSAC'S LAW—ITS CENTENARY.

GAY-LUSSAC'S law regarding the composition of gases by volume was made known about a hundred years ago. The paper in which he elaborated it, having been read to the Société philomatique on December 31, 1808, was published in the Mémoires de la Société d'Arceuil in the following year. Since then the law has come to have a history of its own. Chemists were at a loss and made many efforts to get it and the atomic theory to suit one another, and the place of the law in science, though not now likely to change, was for long unsettled and dubious.

Ostwald puts the law in the following way:—"If several gases appear or disappear in a chemical change, they do so always in simple ratios by volume." For example, one volume of hydrogen and one of chlorine yield two volumes of hydrochloric acid, and, again, one volume of oxygen and two volumes of hydrogen give two of steam.

The composition of nitrous and nitric oxides and numerous other gases was discovered for the first time by Gay-Lussac. But no one who has paid much attention to the history of science can be surprised that observations had been made earlier in the same field. William Higgins knew that hydrogen and oxygen combine, yielding water, in the proportion 2 : 1, and this was probably only a version of Cavendish's result. He knew also Austin's experiment proving that sulphuretted hydrogen contains its own volume of hydrogen, and he had himself observed that sulphur dioxide contains its own volume of oxyyen. It must

be admitted that Higgins, who stated these facts and reasoned very justly upon them in his "Comparative View of the Phlogistic and Anti-phlogistic Hypotheses" (1789), did not give any sign, by collating them, that he felt himself on the threshold of a great discovery. Again, Gay-Lussac and Humboldt, taking up the study, for purposes of eudiometry, of the combination of hydrogen and oxygen, found the ratio between these gases to be 2 : 1 as nearly as they could measure. This was in 1804. The observation arrested Gay-Lussac's attention. Curious to find if other such-like cases exist, he began work which resulted in the discovery of his law, one of the most important in science.

Gay-Lussac, like Newton, did not form hypotheses. The memoir in which he set forth his work is remarkably free from speculative matter. His conviction was that "in natural science, and above all in chemistry, generalisation should come after and not before a minute knowledge of each fact." And assuredly the history of Gay-Lussac's law in science does show that a "law of nature" may prove a dangerous weapon to the man who puts it to theoretical and practical uses, before its range and bearings in nature have been accurately fixed.

The law when published aroused the widest interest. The world of science was just then pondering the atomic theory in the form impressed on it by Dalton, and it was obvious that theory and law must stand in the most intimate relation to one another. Strangely enough, the law was objected to by Dalton of all people, and by him alone. In the second part of his "New System of Chemical Philosophy," published in 1810, he made strictures on it, and concluded :—"The truth is, I believe, that gases do not unite in equal or exact measures in any one instance; when they appear to do so, it is owing to the inaccuracy of our experiments. In no case, perhaps, is there a nearer approach to mathematical exactness, than in that of one measure of oxygen to two of hydrogen; but here the most exact experiments I have ever made gave 1·97 hydrogen to 1 oxygen." Berzelius wrote to Dalton protesting in the most courteous way against the part of the atomic theory "which obliges you to declare as inaccurate the experiments of Gay-Lussac, on the volumes in which gases combine. I should have thought rather that these experiments were the finest proof of the probability of the theory; and I confess to you, that I will not so readily think Gay-Lussac at fault, especially where the point is one of good or of bad measurement." Nothing, however, could ever remove the distrust Dalton felt in the law.

The chemists who accepted both Dalton's theory and Gay-Lussac's law had themselves to solve the problem of defining the relation between the two. No more than Dalton would Gay-Lussac do anything to help them. Even so late as the year 1814, in his memoir on iodine, and in the one on prussic acid of the following year, he ignores the atomic theory. He uses the word "molecule" for the sake of convenience, and that is all. Yet there must be a connection between the specific gravities, that is, the weights of equal volumes, of different gases and their atomic weights. This connection is the primary subject of a paper by Prout, published in 1815. Here he advanced his famous hypothesis that the atomic weights of the elements are multiples of the atomic weight of hydrogen, but there is good reason to think that the hypothesis was conceived after the data had been rounded off.

Berzelius had already, in 1813, if not earlier, given his solution of the problem. This was his "volume-theory," that equal volumes of different gases contain the same number of atoms. This hypothesis affords a basis of a purely physical kind for the determination of atomic weights, for it means that the atomic weights of different gases stand in the same ratio to one another as the weights of equal volumes of the gases.

The "volume-theory," plausible as it seems, involved its author in difficulties one after another, which finally became overwhelming. One arises as soon as the theory is formulated. Each atom of hydrogen, on combining with chlorine, could, as Berzelius and Dalton understood the atom, yield only one compound atom of hydrochloric acid. But the volume of the hydrogen is half that of the hydrochloric acid which it produces, so that the atom of the element occupies only half the volume of the compound atom. Hence the theory must either be limited to elements, or given up altogether. Years before Dalton had to face the same difficulty in the case of nitric oxide. What he did at first was to abandon outright the hypothesis that atoms of different gases have the same volume, and then to object even to Gay-Lussac's law. Dalton was "for thorough." What Berzelius did was to make the "volume-theory" apply only to the elements.

In course of time another difficulty appeared. The atoms of many important elements seemed to enter into combination only by pairs. This strange result arose in the following way. Berzelius began in the year 1826 to ascribe the general formula RO to all strong bases. Now, by the chemical equation for the formation of a chloride from a base—$RO + H_2Cl_2 = RCl_2 + H_2O$—it is plain that the amount of acid needed to form a chloride with one molecule of a base contains two atoms of hydrogen and two of chlorine. That is, as Berzelius saw, the hydrogen enters into chemical combination in pairs, and so does the chlorine atom.

This, be it noted, involves a conception of the element which is precisely the reverse of the modern one. Hydrogen is now supposed to consist of physical atoms, each of which can be halved when it enters into chemical combination. The physical atom of hydrogen is composed of two chemical ones. Berzelius had formed the conception of a chemical atom composed of two physical ones. It applied to quite a large number of elements in addition to hydrogen, namely, to chlorine, fluorine, bromine, iodine, nitrogen, phosphorus, antimony, and arsenic.

The very natural comment on this was made by Gmelin, that the "existence of the physical atom was improbable and its adoption superfluous and troublesome." One could arrive at Gmelin's system of chemical formulæ by suppressing every pair of physical atoms in Berzelius's formulæ, and putting in a chemical atom instead. Thus H_2O became HO. Nobody could help seeing that Berzelius's system simply led the way to Gmelin's. This was a great blow to the "volume-theory," for Gmelin's system differs from Berzelius's only by leaving out the "volume-theory" and all its consequences.

The above as an objection to the theory was perceived and felt to be overwhelming only in course of time. As already explained, from the first the theory could include in its scope only the elements. But before long Berzelius had to limit the theory still further. So long as it is applied to elements the molecules of which are of the same degree of complexity, hydrogen and oxygen, for instance, the physical method of finding atomic weights is in agreement with the chemical. The ratio H_2/O_2, which the former method gives, is the same as the ratio H/O given by the latter. But this is a matter of accident. About the year 1826 Dumas succeeded in finding the vapour-density of elements such as mercury and phos-

phorus, and was therefore enabled to calculate their respective atomic weights by the physical method. For mercury the ratios are Hg/O_2 (physical) and Hg/O (chemical), and for phosphorus P_4/O_2 (physical) and P/O (chemical).

These discrepancies forced Berzelius to limit the "volume-theory" to gaseous elements, and to such as are easily converted into gas. Finally, when discrepancies, no less serious, arose in the case of sulphur and of arsenic, he decided to abandon the theory. This was in 1833, after he had held to it for twenty years.

The only sound application of the law to theoretical chemistry was made by Avogadro in 1811. In considering his teaching, it is best to set aside the word atom and its associations, at least in the first place, and to use the word "molecule" instead. Avogadro's hypothesis is that equal volumes of different gases contain the same number of molecules. In that case the weights of equal volumes of gases are proportional to their molecular weights.

The hypothesis has a special and important consequence regarding the constitution of the molecule. For instance, each molecule of hydrogen, with the necessary chlorine, yields two molecules of hydrochloric acid. But each molecule of the acid contains hydrogen, and therefore the hydrogen molecule has certainly been halved. This conception of the molecule of an element as a thing which may consist of parts is an inevitable consequence of Avogadro's hypothesis, and it was boldly accepted by him. The mere possibility of such a thing was scouted by Thomson, and Berzelius, and Graham as utterly subversive of the atomic theory. Yet it forced itself forward again and again upon Ampère, Dumas, Prout, Waterston, Krönig, Gerhardt, Laurent, Clausius. Finally, in 1860, Cannizzaro was able to convert chemists to Avogadro's hypothesis and all its consequences. Since then the hypothesis, based as it is upon Gay-Lussac's law, has been the fundamental doctrine of chemistry.

One thing about the definition of the law is worth noting. Nothing is said in it, but much is implied, regarding the conditions under which the gases are measured. The teacher would do well to direct attention to this. There is the obvious assumption that the different gases concerned in a particular experiment are measured under the same temperature and pressure. But the definition implies another assumption, namely, that different gases behave in the same way under the same conditions. Otherwise the combining ratio, say, of hydrogen and chlorine, could not remain constant over a range of temperature and pressure.

Of course, we know that the combining ratio of two gases does not remain strictly constant when the conditions alter. The fact that a gas such as carbon dioxide deviates considerably from Boyle's law and Charles's law leads to the expectation that Gay-Lussac's law is itself only an imperfect description of the facts. The expectation is verified, for even the combining ratio of hydrogen and oxygen is not strictly 2 : 1, but has been ascertained to be 2·00285 (Scott), 2·0037 (Leduc), and 2·0027 (Morley). This is an important consideration, for molecular and atomic weight data obtained on the assumption that Gay-Lussac's law is strictly accurate must be defective. The physical method cannot lead to the same result as the chemical until a correction is introduced, and then the discrepancy is found to disappear. One systematic way of making this correction has been devised and used by M. Daniel Berthelot, and another by M. Guye.

Berzelius was led into a grave numerical error by his unqualified acceptance of Gay-Lussac's law. In the year 1819, in conjunction with Dulong, he determined the atomic weight of carbon by the physical method. The process adopted was to weigh a certain bulk of carbon dioxide and subtract the weight of the same bulk of oxygen. The difference is the weight of the carbon, on the incorrect assumption that carbon dioxide contains exactly its own bulk of oxygen. The atomic weight was found to be 76·44 (O = 100) or 12·23 (O = 16). This datum, which as a matter of fact is much too high, was long used in chemistry. Berzelius should not have fallen into this error, for he had received a warning two years before against the danger of the physical method. He had determined the atomic weight of sulphur by an experiment, similar to the carbon dioxide one, with sulphur dioxide, and he set aside the result, which was 103·35 (O = 100), because it differed so much from the figure, 100·7, which he had obtained by a chemical method.

Dumas and Stas found it necessary, in the year 1839, to embark on a re-investigation of the atomic weight of carbon. Dumas had been analysing the hydrocarbon naphthalene, and had obtained the anomalous result, again and again, that the percentages of carbon and hydrogen added up to much more than 100. As a result, the atomic weight of carbon was found to be 75·00, instead of 76·44, as Berzelius had said.

This was a severe blow to Berzelius. He had endured many reverses. One cherished conviction of his had gone after another. Chlorine and nitrogen had proved to be elements and not compounds of oxygen, the "volume-theory" had become untenable, his electrochemical theory was undermined, and his system of chemistry was threatened by Gmelin. Berzelius was yet the great master of atomic-weight determination. Even that satisfaction was now denied him; none of his atomic weights was to be above suspicion any longer, all because he had made an unjustified use of Gay-Lussac's law, twenty years before. There is a strange irony in the difficulties in which Berzelius involved himself time and again by his use of this law, in view of the protest he had made against Dalton's refusal to accept it.

A. N. MELDRUM.

ANEMOGRAPHIC OBSERVATIONS IN INDIA.[1]

MOST of these memoirs are by the late Sir John Eliot, whose loss, while he was still capable of much useful work, all meteorologists deplore. They deal with the changes in wind direction and force at the stations, showing both the diurnal and the seasonal variations, and form a store-house of information for anyone who wishes to study the Indian monsoons.

Saugor Island is situated in the north-west of the Bay of Bengal on the coast, about sixty-five miles in a direct line from Calcutta, and ninety if the bends of the river are followed. The land around it is perfectly flat, and only a few feet above the sea, so that the exposure is an excellent one.

The land at Alipore is also flat, but there are many trees in the district the tops of which are level with or above the anemometer. As might be expected, the winds are far stronger at the coast station.

Saugor Island lies in the track of the circular storms (cyclones) of the Bay of Bengal, and it is of interest to compare the maximum hourly velocity in these

[1] A Discussion of the Anemographic Observations recorded at Sangor Island from March, 1880, to February, 1904. Also at Alipore, Calcutta, from March, 1877, to February, 1904. Vol. xviii., part ii. Also at Pachmark from September, 1883, to April, 1887. Also at Nagpur from January, 1882, to December, 1902. Vol. xix., part i. At Roorkee from September, 1879, to August, 1904. At Lahore from January, 1889, to May, 1905. At Mussoorie from May to October, 1877 to 1888. (London: Harrison and Sons.)

storms with that which occurs in other places. Unfortunately, the factor that has been used is not given, but it is probably the old erroneous factor 3. It is in few years that this velocity exceeds 50 miles per hour—37 on the present scale of the Meteorological Office—and there are few stations on the British coast at which this is not often exceeded. One instance of 90 (66 corrected) is given.

It does not seem unlikely that the violence of the tropical hurricanes is somewhat overestimated owing to the contrast with the usual calm of the tropics, and also, perhaps, because the proximity of violent winds from different directions produces a very irregular and dangerous sea.

The memoirs also contain curves showing the direction and magnitude of the daily variation. The results for St. Helena have lately been treated in a similar manner with very interesting results. The daily oscillation of the barometer, more particularly the second term in the harmonic series with the twelve-hour period, must be associated with the transfer of a considerable mass of air from place to place, and it is of interest to try and trace this transfer in the anemometric records from various parts of the globe. These variations, as they are shown at the mouth of the Ganges and in Northern India, are very fully discussed. The conditions are naturally very different at the different stations, both in space and with the changing seasons, and the causes that produce local winds are so complex that it is almost hopeless to try and correlate cause and effect. At all the stations the change from hour to hour seems to be large by day and small by night, from which one may perhaps conclude that local heating by the sun plays an important part in the phenomena.

Although the observations at Mussoorie were only taken during the summer, they are of especial interest, since the station stands on the summit of one of the outer ridges of the Himalayas at an elevation of some 6500 feet above the sea. The hourly and monthly values, as at the other inland stations, are very complex; but there is, as might be expected, a distinct tendency for the air to run up the slope of the mountains during the day and down during the night. Naturally, also, the winds are stronger than at the stations in the plains.

ROCK PAINTINGS OF THE LOWER EBRO.

A VERY interesting article on this subject by MM. l'Abbé Breuil and Juan Cabré appeared in the January–February number of *l'Anthropologie*. The first part of the paper deals with the painted rocks on the Calapatà at Cretas (Teruel) first observed by M. Cabré in 1903, although it was not until 1906 that he communicated his discovery, having then realised its significance in relation to Quaternary art. The pictures, which are painted under a shallow shelter, represent animals in various attitudes, and show considerable vigour of execution. Close by, flint flakes are to be found which exhibit no Neolithic characters, but rather Magdalenian. The paintings comprise three deer, a bull, and a small subject difficult to determine. All are done in dark red, and are outlined by a very lightly engraved line; certain details, such as eyes and nostrils, are added in the same way, as they would not otherwise appear in a monochrome without shading. The first deer, measuring 30 cm. by 25 cm., is represented in a graceful attitude in the act of rising to its feet; the second (33 cm. by 27 cm.) is walking rapidly towards the first, the movement being admirably depicted. It is interesting to note that in all the stags drawn in profile the antlers are conventional, as if seen partly from the front, partly from the side. This curious disposition of the branching is met with, not only at Cretas, but also at Cogul (Lerida), and in France in the reindeer drawings of the Portel grotto. This points to a closer connection in late Quaternary times of the tribes of Aragon and Catalonia with those of the Ariège than with any others.

The second part of the article describes a series of rock paintings at Cogul, in Lerida (Catalonia), which was brought to the public notice in 1907. The surface painted measures about 2 m. across, and lies beneath a ledge of rock. Altogether there are five distinct pictures. Two are hunting scenes, of which the figures are drawn schematically. M. C. Rocafort regards this as a hieroglyphic inscription, possibly of the Iberian period, but the authors consider that it cannot be thus separated as regards date from the accompanying paintings. The third picture (measuring 75 cm. across) represents a stag surrounded by hinds. The animals of this group are less realistic than those of Cretas, but none the less the execution is delicate, and the attitudes graceful and lifelike.

The right-hand lower scene apparently represents nine women dancing round a man, four being to the right of the man, and five to the left. The man is much smaller than the women, and has no clothing beyond an ornament at the knees; the women are all wearing petticoats reaching to the knees, while the upper part of the body is bare. The figures are painted in black, red, or black and red; the man is dark brown rather than black. The outlines of the four right-hand figures are emphasised by engraving. The whole group measures 68 cm. across.

The dress of the women presents a superficial analogy with the Cretan series, but the lifelike character of the Minoan figures and many details are in strong contrast with the stiffness of the Cogul "ladies." Much more definite evidence would be necessary in order to establish any connection between the two series.

The style of the animal frescoes at Cogul, as of those of the Calapatà (Cretas), is that of our Quaternary drawings, not of later art. This indication is corroborated by the presence, not far from the painted rock at Cogul, of small Magdalenian stations with numerous flint flakes (in some cases retouched) of the type usual in France. Thus it is certain that in the immediate neighbourhood of the painted rocks there existed stations of the late Palæolithic age, contemporary with our civilisation of the Reindeer age; it is also highly probable that the whole of these open-air frescoes are to be attributed to the peoples living there; those of single animals afford further beautiful specimens of Quaternary art in animal-drawing. The hunting pictures at Cogul introduce a historic scenic episode as yet unknown in mural art. The dancing scene described raises a small corner of the veil drawn over the social life of those remote ages, and the style of dress tells us something of the use to which the Magdalenian seamstresses put those fine eye-needles which the caves of the Cantabrian Mountains, the Pyrenees, and Dordogne have so long yielded to the astonished eyes of investigators.

PROF. HUGH BLACKBURN.

THE unexpected decease of Prof. Hugh Blackburn, who occupied the chair of mathematics in the University of Glasgow from 1849 to 1879, was announced by Principal Sir Donald MacAlister to the great audience of students and friends assembled to hear the inaugural address of Prof. Gibson. The news came as a great shock to such former students as were present, among them his then retiring

successor, Prof. Jack, and Prof. Gibson himself, and Prof. Blackburn's old student, colleague and life-long friend, Prof. Ferguson. It was well known that Prof. Blackburn's health had broken down seriously in the spring, and that there had been no sensible improvement, but the actual news was unexpected.

Prof. Blackburn's family have been connected with Glasgow for at least three centuries. An ancestor of his, Peter Blackburn, was one of the "regents" of the slowly growing University, from 1574. He was appointed when the Town Council handed over to the University grants made to themselves of lands and buildings by Queen Mary in 1567. From that time until Peter Blackburn was appointed a regent in 1874 the University had been all but moribund. Blackburn was brought from St. Andrews, where he had graduated, and he acted as regent shortly before the arrival of the great reformer Andrew Melville. During Melville's epoch-making six years as principal, and for two years after it, Mr. Blackburn acted as third or principal "regent." The regents used each to take the students committed to them through all their subjects, and for their whole university course. Melville revolutionised this system, setting each regent to teach some special branch of the graduation course to all the students. Mr. Blackburn was, in fact, "professor" of physics and astronomy in the modern sense until he left for Aberdeen, two years after Melville had left for St. Andrews.

It is curious to find the name Peter surviving after three centuries in the family of which Prof. Blackburn was a member. His eldest brother was Peter Blackburn, long M.P. for Stirlingshire and chairman of the Edinburgh and Glasgow Railway before it was merged into the North British. His second brother, Colin Blackburn, afterwards the famous Lord Blackburn of the High Court of Appeal, was eighth wrangler in 1835, and Hugh Blackburn, the youngest brother, was fifth wrangler in 1845. It was a memorable year at Cambridge. William Thomson, afterwards Lord Kelvin, then a boy of eight, came across from Belfast to Glasgow, where, in 1832, his father had been appointed professor of mathematics. At the age of twenty-one he was second wrangler and first Smith's prizeman, and founder and editor of the famous *Cambridge and Dublin Mathematical Journal*. To its first volume Prof. Blackburn contributed a paper on the variation of elements in the planetary system. Nothing quite like that first volume had previously appeared in the British mathematical world. Side by side with Prof. Blackburn's paper were one by Cayley (senior wrangler in 1842); a note on induced magnetism on a plate, by William Thomson; a paper by Sir William Rowan Hamilton, Irish Astronomer Royal; and another on quadrature of surfaces of the second order, by Mr. John H. Jellett, fellow and tutor, and afterwards provost, of Trinity College, Dublin. In the same volume there were papers by Leslie Ellis, senior wrangler in 1840; by Boole, afterwards the famous professor at Cork; by Augustus de Morgan, London; by Stokes, senior wrangler in 1841; by D. F. Gregory, fifth wrangler in 1837; by Townsend, of Dublin, and Liouville, of Paris, with four other papers by the young editor himself. In that splendid galaxy of men of mathematical genius Prof. Blackburn took a distinguished place, and he had deeply impressed his friends, and Thomson, no doubt, in particular, by inventing and exhibiting in his rooms his well-known pendulum with double suspension. A little later the two young Scotchmen, Thomson and Blackburn, went to Paris together on a mathematical and physical pilgrimage, and all their lives they remained attached and devoted friends. In 1871 they published together the full text of Newton's "Principia." Later, Prof. Blackburn published a revised and extended edition of Sir George Airy's treatise on trigonometry from the "Encyclopædia Metropolitana," which appeared in a separate cabinet form in 1855.

William Thomson entered in 1846 on his splendid tenure of the chair in natural philosophy in Glasgow, which he filled for fifty-three years. Two years later his father, the professor of mathematics there, died unexpectedly, and it was probably largely due to Thomson's entire conviction of the exceptional mathematical ability of his friend that Prof. Blackburn was appointed in 1849 to succeed Prof. James Thomson.

His students always felt for him the greatest affection and respect. Every teacher's qualities are appraised by the world very much as Mr. Lowe used to judge primary teachers under the famous revised code—by results. Prof. Blackburn had many distinguished pupils who took high places in the mathematical world. I may name Dr. Thomas Muir, who was an admirable assistant to the professor, and who has never, in spite of his engrossing duties as director of education in Cape Colony, intermitted his work on determinants. There was Sir Charles Abercrombie Smith, formerly Auditor-General in Cape Colony and now Vice-Chancellor of the Cape University; Mr. Dickson and Mr. Dodds, formerly tutors of Peterhouse; Prof. Pinkerton, of Cardiff, and Mr. Nixon, of Balfast. But Prof. Blackburn was much more than a mere mathematician. His university speedily discovered his administrative and financial strength, and made him successively convener of its library and its finance committees. Mr. Blackburn was, perhaps, more trusted and more responsible than any of his colleagues in the removal of the old college from the site it had occupied for four centuries, after it had become unsuitable and perhaps insanitary, to the present splendid buildings. Among his colleagues his authority was always great, and he owed this to the strength and simplicity of his character, and to the clearness of his practical and judicial mind. Students and colleagues alike, who knew him better than others could, honoured him and believed in him. Of a sensitive and artistic nature, he did not, however, care, after thirty years, to continue services which increasing deafness made irksome and difficult.

For years, Prof. Blackburn, in declining strength and health, never left the estate, beyond the Mull of Ardnamurchan, where he had found a home in 1879, and where he died. W. J.

NOTES.

SIR RAY LANKESTER writes to inform us that he has heard from the representatives of the late Prof. Anton Dohrn to the effect that the Zoological Station at Naples remains the property of the heirs of its founder. Neither the German Government nor any German society have acquired any rights in its future disposition. Dr. Reinhardt Dohrn, who has for two years been the acting director of the Zoological Station of Naples, is now director, and has inherited from his father (by agreement with his brothers) the actual property and the leases granted by the Naples municipality as to the site. We wish Dr. Reinhardt Dohrn success and happiness in carrying on the work of his eminent father.

THE Meteorological Office has received reports of observations of an aurora on the nights of October 17, 18, and 19, at several places in England, Scotland, and Ireland. An aurora is also reported in the French *Bulletin International* as having occurred at Haparanda on the night

of October 18, and vessels engaged in the Transatlantic trade report an unusually brilliant display of aurora on the same night—October 18–19—over practically the whole route between Europe and the United States of America. In connection with these reports, it is of interest to note that considerable magnetic disturbance was recorded at Kew on October 18–19, though nothing at all approaching that recorded on the late occasion. The whole afternoon of October 18 was slightly disturbed magnetically, but there was a marked sudden development about 8.30 p.m., and a considerable disturbance prevailed thereafter until 6 a.m. on October 19. During this time there was a range of $37\frac{1}{2}'$ in the declination, of 130γ in the horizontal force, and of 170γ in the vertical force. The most noteworthy features were that the declination needle remained to the east of its normal position continuously from 8.30 p.m. on October 18 until 3.30 a.m. on October 19, while the vertical force was depressed below its normal value from the commencement of the storm until 7 a.m. next morning. There was further disturbance, but of a minor character, later on October 19.

MR. W. E. COOKE, Government astronomer, Western Australia, informs us that the most magnificent aurora visible in Australia for half a century occurred on September 25. From reports in the *West Australian*, it appears that the aurora was observed throughout Australia, as well as at Cocos Island, Batavia, Singapore, Rodriquez, Durban, and elsewhere. Magnetic disturbances appear to have been recorded generally, interfering considerably with the telegraph and cable services. The electrical engineer in the Western Australia railway department (Mr. Dowson) informed Mr. Cooke that for the space of half an hour on the evening of Saturday, September 25, the lines between Perth and Kalgoorlie (350 miles), and between Perth and Albany, worked well with all the batteries cut out. The current was at least double that which is usually employed, and the needle of the ammeter went hard over at 35 milliamperes. The pressure must have been at least 150 volts. As the auroral light waxed and waned the current followed suit. By a curious coincidence, the last great display in Australia occurred almost exactly fifty years ago.

THE Bakerian lecture for the session 1908–9 will be delivered at the Royal Society on Thursday, November 18, by Sir J. Larmor, Sec.R.S., on "The Statistical and Thermodynamical Relations of Radiant Energy."

THE annual Huxley memorial lecture will be delivered by Prof. Gustaf Retzius on Friday, November 5, at the Royal Anthropological Institute. The subject will be "The North-European Race."

RECENT American obituary includes the name of Dr. Hermann Endemann, a German by birth, who was for several years one of the editors of the publications of the American Chemical Society, and frequently appeared as an expert chemist in the courts and before legislative committees at Washington and Albany.

MR. HORACE G. KNOWLES, recently U.S. Minister at Bucharest, has been so impressed by the value of the sturgeon fisheries of the Danube that he is making an attempt to re-introduce the sturgeon into the rivers of the Atlantic coast, where for many years it has been almost unknown. He has obtained the consent of the Rumanian Government to the shipment to America of a car-load of the fry of the Black Sea sturgeon, said to be the best in the world. His efforts are warmly approved by the U.S. Fish Commissioner, who believes the experiment will be successful.

THE Secretary of State for the Colonies has appointed an advisory committee on medical and sanitary questions connected with the British Colonies and Protectorates in Tropical Africa. The members of the committee are:—Mr. H. J. Read, C.M.G. (chairman); Sir Patrick Manson, K.C.M.G., F.R.S.; Sir Rubert Boyce, F.R.S.; Mr. C. Strachey; Mr. W. T. Prout, C.M.G.; Dr. T. Thomson, C.M.G.; Prof. W. J. Simpson, C.M.G.; and Dr. J. K. Fowler. Mr. A. Fiddian, of the Colonial Office, will act as secretary to the committee.

AT the general meeting of the Royal Society of Edinburgh, held on October 25, the following office bearers and members of council were elected:—*President*, Sir William Turner, K.C.B., F.R.S.; *vice-presidents*, Dr. R. H. Traquair, F.R.S., Prof. Crum Brown, F.R.S., Prof. J. C. Ewart, F.R.S., Dr. J. Horne, F.R.S., Dr. J. Burgess, Prof. T. Hudson Beare; *general secretary*, Prof. G. Chrystal; *secretaries to ordinary meetings*, Dr. C. G. Knott, Dr. R. Kidston, F.R.S.; *treasurer*, J. Currie; *curator of library and museum*, Dr. J. S. Black; *councillors*, Prof. F. W. Dyson, F.R.S., Prof. D'Arcy W. Thompson, C.B., Dr. O. Charnock Bradley, C. Tweedie, Prof. J. W. Gregory, F.R.S., Dr. A. P. Laurie, Prof. Wm. Peddie, Prof. H. M. Macdonald, F.R.S., Prof. D. Noël Paton, Dr. W. S. Bruce, Prof. F. A. Baily, J. G. Bartholomew.

THE council of the Institution of Civil Engineers has made the following awards for the year 1908–9:—Telford gold medals, Prof. B. Hopkinson and G. R. G. Conway; Watt gold medals, D. A. Matheson and W. C. Popplewell; George Stephenson gold medals, E. H. Tabor and A. J. Knowles; the "Indian" premium and a Telford premium, T. R. Nolan; Telford premiums, S. J. Reed, C. T. Purdy, L. A. B. Wade, G. Hobbs, W. Cleaver, J. D. W. Ball, Prof. A. H. Gibson, and R. D. Gwyther; the "James Forrest" medal and a Miller prize, J. A. Wotherspoon; the Miller scholarship, J. A. Orrell; the "James Prescott Joule" medal and Miller prizes, W. E. Fisher and E. B. Wood; Miller Prizes, W. E. R. Gurney, E. G. L. Lovegrove, J. Purser, G. C. Minnitt, S. F. Deacon, C. H. Bradley, and A. E. Marshall.

NEWS of large disturbances of seismographs by distant earthquake shocks was recorded in the *Daily Mail* of Friday, October 22, by Prof. Milne (Shide, Isle of Wight), Prof. Belar (Laibach, Austria), and Prof. Michie Smith (Kodaikanal, southern India). The earthquake occurred at 11.47 p.m. Greenwich time, and the duration of the motion was more than three hours. Prof. Milne's records indicated that "its origin was about 80° distant, which is about the distance of Japan, San Francisco, and Mexico. The probability is that it occurred in the east." Prof. Belar reported that "the place of origin was distant about 3750 miles to the east." On the following day telegraphic messages from Calcutta and Simla announced that there had been a great earthquake in Baluchistan. Belput, about two hundred miles from Quetta, is said to have suffered severely from the earthquake.

ON Thursday last, October 21, the King performed the ceremony of opening the new Royal Edward Tuberculosis Institute at Montreal by means of an electric current sent from West Dean Park, Chichester. A special telegraph line was laid from West Dean Park to Chichester, and from there the General Post Office lines were used to the Royal Exchange office of the Commercial Cable Company. The line used by the Commercial Cable Company was their shortest route *via* Waterville (Ireland) to Canso (Nova Scotia), from where it was transmitted by land lines to

Montreal. The arrangements made by the cable company were such that by means of relays and repeaters at the intermediate points the signal sent by the King travelled the whole distance without manual help. The current transmitted from West Dean Park released a current at Montreal which opened the doors of the new institute, hoisted a Union Jack, and turned on the electric light. This is, we think, the first time that a ceremony of this kind has been performed at such a distance, namely, 3000 miles, without any outside assistance, and shows the great advance that has been made in telegraphic transmission of late years. Within one minute of the key being pressed at West Dean Park a return signal was received from Montreal intimating that the ceremony had been performed satisfactorily, and a message of congratulation was sent by the King to the manager of the Commercial Cable Company within four minutes of the first signal. All these facts prove that modern telegraphic instruments are becoming more and more efficient, and the latest accomplishment will doubtless advance the closer relationship between the Mother Country and the colonies.

THE United States Government, says *Science*, is now carrying on work at regular forest experiment stations similar to the agricultural experiment stations in the different States. The first forest experiment station created was the Coconino Experiment Station at Flagstaff, Arizona, established in 1908. Investigations covering many phases of forestry in the south-west have already been undertaken at this station. The second forest experiment station has been established this year on Pike's Peak, Colorado. The need for such stations becomes apparent when the long time necessary for handling forest experiments is considered; in forestry, because of the long time required for trees to develop, scores of years are often required to complete a single experiment. All experimental work is conducted under the direction of men who have had training in technical and practical forestry. The greatest technical problem which now confronts the forester in handling the great pine forests of Arizona and New Mexico is that of establishing a new stand of trees to replace the old timber which is cut off. This was the first problem undertaken by the Coconino Experiment Station. Much information regarding the factors influencing natural reproduction has been secured already, but many years of systematic study will be required to solve the problem. The feasibility of artificial regeneration by planting and sowing is also being tested. The plans for the near future provide for a detailed study of the problems concerning the natural and artificial regeneration of other commercial trees, such as Douglas fir, Engelmann spruce, and the junipers.

WE learn from the *Pioneer Mail* that a committee has been appointed for establishing a Pasteur institute in Burma, and is actively engaged in forwarding the scheme. Recently the Secretary of State intimated, in view of the straitened condition of the provincial finances of Burma and of the fact that there was no guarantee that the initial capital outlay on the institute would be met from private subscriptions, sufficient cause to resort to public money had hardly been made out, and consequently regretted his inability to sanction the project as outlined in the first instance. A subcommittee, appointed to formulate a working scheme for the building and equipment of the institute, has reported, and is of opinion that it is possible to provide for bare requirements for one-half of the available capital. The institute, it is hoped, will in course of time find itself in proximity to a general bacteriological institute, and it is considered desirable that the buildings of the institute shall be permanent and substantial, so that they will be a creditable feature of the entire group of buildings to be constructed ultimately for scientific research. The subcommittee recommends, also, that the institute should be under the direction of an officer specially selected in the United Kingdom for his success in bacteriological research. Such an officer, it is suggested, should be appointed on a special agreement, and should not expect transfer, war service, pension, private practice, or any other of the special privileges open to members of the Indian Medical Service.

THE third part of vol. vi. of the Annals of the South African Museum is devoted to the continuation of Messrs. Gilchrist's and Wardlaw's description of a collection of fishes from the coast of Natal, among which several are new.

IN a paper on the remains of Carboniferous air-breathing vertebrates in the U.S. National Museum, published in No. 1696 of the Proceedings of that institution, Mr. R. S. Moody directs special attention to the reptile *Isodectes punctulatus*, on account of its bearing on the origin of the reptilian class. The type and only known specimen, which lacks the skull and nearly the whole of the fore-limbs, and measures less than 6 inches, is redescribed in detail. It displays indications of affinity with the Microsauria, but its ordinal position among reptiles cannot be determined. Several new amphibians are described in the paper.

TO the October number of the *Popular Science Monthly* Prof. W. A. Locy contributes a thoughtful article on the service of zoology to intellectual progress. The study of this science has been a great factor in the cultivation of straight thinking; "its influence has been great in clearing the atmosphere of thought, in dispelling clouds, and in freeing the mind from the bonds of inherited prejudice and traditional superstition." Another result was the conception of the constancy of nature, and, in particular, the idea that all animal life is the result of one continuous and orderly progress. As regards the practical applications of zoology—often in connection with botany—these have been exemplified during the last decade by the wonderful discoveries as to the modes in which diseases are introduced into the human systems by the intervention of insect and other animal carriers, while scarcely less important are the benefits which a knowledge of heredity has conferred upon breeders. Finally, there is the crowning service which zoology has conferred upon mankind in enabling us to realise the existence of evolution, which is so comprehensive in its extent that it enters into all realms of thought, and largely aids in teaching man to comprehend himself, and in some dim degree to understand his own future destiny.

IN a pamphlet entitled "Breeding Horses for Use, or Equine Eugenics," published by Messrs. Swan Sonnenschein and Co., Ltd., Mr. Francis Ram seems well pleased to play the part of Cassandra, for he tells us that, six-and-twenty years ago, he issued under the same title an unanswerable pamphlet, and that if the advice contained therein had been followed a sum of at least 100,000,000*l.* would have been saved to the nation, while the breed of horses would have been vastly improved. The main feature of the scheme seems to be the substitution of stallions for geldings in cavalry and omnibus horses, and the selection from among these, after severe tests of stamina and endurance, of a small percentage for breeding purposes. Perhaps the author might have had a better chance of getting his scheme more carefully considered had he not

run a tilt at judges at horse-shows and other experts, whom he pronounces utterly unfit for their duties. He also seems to possess better vision than most persons, as he asserts that he can see the true position of the limbs of a galloping horse without the aid of photography, while he also accuses Sir Ray Lankester of being in error regarding the position of the legs and feet in a running dog.

IN a paper published in the "Annals and Magazine of Natural History" for 1903, Mr. J. L. Bonhote strongly urged the inadvisability of regarding the numerous island forms of chevrotains as distinct species, and pointed out that there are really only four types entitled to specific rank. This view is entirely ignored by Mr. G. S. Miller in a paper on the mouse-deer (chevrotains) of the Rhio-Linga Archipelago, published as No. 1695 of the Proceedings of the U.S. National Museum, in which a large number of island forms related to the napu are treated as distinct species. Apart from this, Mr. Miller draws some interesting conclusions regarding the development of melanism and other colour-phases in this group. "The only conclusion that seems justified," he writes, "is that the *Tragulus napu* group consists of a series of local species whose colour-pattern, probably for some physiological reason, is varying along two main lines of divergence, both of which are independent of external conditions as ordinarily understood. Each series is equally incapable of explanation by the hypotheses of Lamarck, Darwin, or De Vries. On the larger land-masses such changes as may be taking place are uniform over wide areas and relatively slow, while in the regions which, by submergence, have become divided into small land-areas separated by water the changes are irregular and rapid, though progressing on different islands at a very unequal rate."

MESSRS. WILLIAMS AND NORGATE have forwarded to us the third and fourth parts of the thirty-ninth volume of Gegenbaur's *Morphologisches Jahrbuch*, containing papers on the development of the vertebral column in Echidna and in man, by G. P. Frets; the prothorax of birds and mammals, by T. Funccius; the saccus endolymphaticus, by Giuseppe Sterzi; the segmental theory of the vertebrate head, by B. Hatschek; the swim-bladder of Malacopterygii, by L. F. de Beaufort; and the brain-pattern of the anterior cranial fossa, by E. Landau.

WE have received from the publishers an essay, by Prof. O. Grosser, on the methods of fœtal nourishment amongst mammals (including man), forming part iii. of the collection of anatomical and physiological lectures and essays edited by Profs. Gaupp and Nagel (*Sammlung anatomischer und physiologischer Vorträge und Aufsätze*, Heft iii.; Jena: Gustav Fischer, 1909, price 60 pf.).

THE investigations of the *Challenger* and other deep-sea exploring expeditions have long since made us familiar with the fact that many deep-sea fishes possess luminous organs of various kinds, but one would hardly expect to find such organs in species which live habitually in shallow water. It appears, however, from the observations of Dr. Otto Steche, published in a recent number of the *Zeitschrift für wissenschaftliche Zoologie* (Band 93, Heft iii.), that we must modify our ideas on this subject. *Anomalops katoptron* and *Photoblepheron palpebratus* are two fishes which inhabit the shallow waters of a coral reef in the Malay Archipelago. In each case the luminous organ is a large oval body lying beneath the eye. The author was able to keep the fish in captivity, and gives some interesting particulars of the behaviour of the organ in the living animal, as well as a detailed account of its microscopical structure. It appears that the fishes are well known to the native Malays, who actually make use of the luminous organs for catching other fish, cutting them out and attaching them to the hook above the proper bait, under which conditions they will remain luminous for some hours, a fact which throws an interesting sidelight on the function of such organs. The fishes themselves are, as one would suppose, predaceous, feeding on all the small inhabitants of the coral reef, especially crustacea.

A NOTE on tamarisk manna is contributed by Mr. D. Hooper to the Journal and Proceedings, Asiatic Society of Bengal (vol. v., No. 2). The substance is obtained from the halophytic shrub *Tamarix gallica* and from *Tamarix articulata*, while the species *Pallasii* yields an inferior sweet gum. It has not been ascertained whether the manna is produced by insect agency or is a natural secretion of the plant. The ordinary method of extraction consists in pounding the branches or leaves; the saccharine ingredient of the manna was found to be cane-sugar. A curious occurrence of manna was observed on certain land in Seistan which was subject to inundation; the manna shed by the tamarisk bushes had apparently dissolved in the water and dried out in lumps as the water evaporated.

ON the subject of nomenclature in connection with plant formations, an article by Dr. R. Gradmann, published in Engler's *Botanische Jahrbücher* (vol. xliii., part iii.), deserves careful attention. It is pointed out that three methods of classification have been advanced, the physiognomic, adopted by Grisebach, the pioneer in this branch of botany; the ecological, exemplified by Warming's "Plant Formations"; and the purely floristic. As regards the last-named, it is observed that while the designation of formations according to dominant and subdominant or typical plants has its practical uses, the only comprehensive system is furnished by a complete list of all the plants for each individual formation. Three points arise out of this paper:—first, the basis for a system of classification; secondly, a convenient designation for each formation; and, thirdly, the means of differentiation between similar formations.

THE *National Geographic Magazine* (p. 822) contains an interesting paper, by Mr. G. R. Putnam, of the United States Coast and Geodetic Survey, on modern nautical charts. The article contains a popular account of the methods of hydrographical surveying and chart construction, and charts of different periods are compared.

THE first number of a new volume of the *Abhandlungen* of the Vienna Geographical Society is devoted to a memoir, by Dr. H. Leiter, on the question of changes of climate in northern Africa during historic times. An exhaustive examination from different points of view shows that there is no evidence that any progressive change of climate has taken place.

WE have received Publications Nos. 3 and 4 of the Finland Commission for Hydrographic and Biological Investigations in the Gulf of Finland. In the first of these Dr. Johan Gehrke discusses at length the variations in the mean values of temperature and salinity in the waters of the gulf, from observations made at three stations during the years 1902–7. The second memoir consists of a table giving hourly values of water-level at Hangö from 1897 to 1903.

CAPTAIN P. K. KOZLOFF contributes an account of the Mongolia-Sze-Chuan expedition, carried out under his charge on behalf of the Imperial Russian Geographical

Society during 1908, to the October number of the *Geographical Journal*. The work of the expedition was to explore certain unvisited parts of Mongolia, to examine Lake Koko-nor, and to investigate the region of the upper course of the Hwang-ho. Amongst the most important results already obtained from the first part of the journey is the identification of the dead city, Khara-khoto, with Hsi-hsia, the capital of a Tangut kingdom which flourished from the eleventh to the fourteenth century.

AN important list of the strong earthquakes felt in the Philippine Islands during the last half-century has recently been issued by the Rev. Miguel Saderro Masô, assistant director of the Weather Bureau. The earthquakes, fifty-five in number, vary in intensity between the degrees 7 and 10 of the Rossi-Forel scale of seismic intensity, five of them attaining the highest degree. The year of maximum activity, when eight strong earthquakes were felt, was 1897, which was also that of the great Assam earthquake; and, during the decade 1890–1900, sixteen strong shocks occurred in the Philippines, while in the same interval no fewer than nine were felt in Japan. The most unstable district in the archipelago is Mindanao, and especially the eastern part of the island, which lies in the neighbourhood of the great geosynclinal of the Pacific Ocean.

AN analysis of the underground temperature at Osaka, western Japan, by Mr. T. Okada and Mr. T. Takeda, is contained in the Bulletin of the Central Meteorological Observatory of Japan, No. 2, 1909. The tables show the hourly mean temperature at depths varying from 0·0–0·6 metre for the years 1901–6, and the monthly mean temperature between 0·0 and 5·0 metres for the years 1895–1904. Below the surface the soil consisted of granite sand. At the depth of 60 cm. the diurnal variation is almost insignificant; the minimum occurs between 2h. and 3h. p.m., and the maximum between midnight and 3h. a.m. The mean annual temperature increases up to a depth of 300 cm. and then decreases; at the depth of 500 cm. the minimum occurs in May and the maximum in November. The total annual heat exchange is computed to be about one-thousandth part of the total quantity of solar radiation received by the surface of the soil.

STORMS of wind and rain have occurred very generally over the British Islands during the past week, and the weather throughout the period was under the influence of cyclonic disturbances, which arrived with considerable frequency from off the Atlantic. On Saturday, October 23, a south-westerly gale blew in most parts of the country, and at Scilly the wind during the evening blew in squalls with a velocity of ninety miles per hour from the westward. In London the aggregate rainfall to the morning of October 27 is 2·65 inches, whilst the average for the whole month is 2·73 inches, and as yet rain has fallen on twenty days this month.

A PRELIMINARY note, by Mr. J. R. Sutton, on the results of observations made during three years upon the diurnal variation of level at Kimberley, is published in the Transactions of the Royal Society of South Africa for July last. It appears from the tables that the movements on the seismograph are very great; the maximum westerly elongation of the pendulum occurs at 5½h. a.m., the maximum easterly about 4½h. p.m., the median positions a little before 11h. a.m. and 9½h. p.m., the mean daily range for the period being 5·5 mm. Not much connection with the weather can be traced; cloud and variations of barometric pressure are thought to be the most potent disturbers in a small way of the regular diurnal march of the pendulum. There was a strong tendency for the pendulum to deviate more and more to the west of its mean position during winter, and to the east during summer.

THE *Philippine Journal of Science* for June (iv., No. 3) contains several papers of importance on protozoology and parasitology, and a study of the diet and nutrition of the Filipino people by Mr. Hans Aron.

WE have received the first part of a volume of memoirs of the Oswaldo Cruz Bacteriological Institute, Rio de Janeiro ("Memorias do Instituto Oswaldo Cruz," Tomo i., Faciculo 1, 1909). The text is in Portuguese, but in parallel column a translation in German, French, or English is given of each article. It contains three excellent coloured plates and other illustrations. Among the contents are a description of a new species of Tabanus, and a contribution on native Tabanidæ, by Dr. Adolpho Lutz and Dr. Arthur Neiva; observations on Brazilian Anophelinæ, by Dr. Neiva; descriptions of two new species of Plasmodia, by Drs. Aragão and Neiva; a study of a new species of Amœba, by Dr. Aragão; studies on tuberculosis, by Dr. Fontes; concentration of diphtheria anti-toxin, by Messrs. Giemsa and Godoy; and the preparation of anti-plague serum, by Dr. Vasconcellos.

A NOVEL type of gas-driven water pump, designed by Mr. H. A. Humphrey, seems likely to find numerous applications owing to its simplicity and high economy. The pump consists of a vertical U tube, having legs of unequal length. The longer leg enters at the bottom of the delivery tank, and the shorter leg is partly immersed in the tank from which the water to be pumped is drawn. The water enters the shorter leg through a number of admission valves, and the upper portion of this leg forms the combustion chamber, and is fitted with admission, exhaust, and scavenging valves, and also an electric ignition device. The gaseous pressure acts direct on the surface of the water in the shorter leg. By taking advantage of the oscillations set up in the water contained in the U tube, and the consequent alterations in gaseous pressure in the combustion chamber, Mr. Humphrey has succeeded in producing a four-stroke cycle, having a long expansion stroke, a long return exhaust stroke, a short suction stroke, and a short compression stroke, at the end of which the charge is ignited. Prof. Unwin has tested this pump, and finds the equivalent coal consumption to be only 1·06 lb. per pump-horse-power hour, a result doubtless owing to the utilisation of the "toe" of the diagram, which is generally wasted in an ordinary gas-engine cylinder.

IN continuation of a previous paper, Prof. James Barnes, of Bryn Mawr College, publishes a note on the new lines in the calcium spectrum in No. 1, vol. xxx., of the *Astrophysical Journal*. The spectra measured were produced by an arc between poles of metallic calcium, enclosed in an exhausted chamber. The first table gives the wave-lengths of two series of triplets previously measured by Kayser and Runge, and three series given by Saunders. The frequencies can be represented by a formula of the Rydberg type, the following giving the first line of each triplet:—

$$\frac{\lambda}{1} = 28911 - \frac{100675}{(m+0{\cdot}927)^2}$$; for λ 4586·1C, the first line of the least refrangible series, $m=3$. There are no lines near λ 6208, which is the approximate wave-length for $m=2$; it therefore appears that the series is a subordinate one, as suggested by Ritz. Prof. Barnes also gives the wave-lengths of the two groups at λ 6382 and λ 6389, observed by Fowler in sun-spots and obtained by Olmsted in the calcium arc in hydrogen, but doubts whether they are due to a compound of these two elements. Between these

two groups other bands were observed, and the wave-lengths are given. It is interesting to note that when the arc-gap was lengthened the line at λ 4227 reversed at the positive pole only, while H and K were much stronger near the negative pole than the positive.

THE concluding part of the first volume of the Memoirs of the College of Science and Engineering, Kyoto Imperial University, contains a second paper by Mr. Y. Osaka on the mutarotation of glucose. It is shown that the velocity of the change of rotatory power which takes place in freshly prepared solutions of this sugar increases between 15° and 25° in the ratio 1/2·7. Sodium chloride has no catalytic action at dilutions below N/15, but at N/10 and N/5 a distinct retardation could be detected, as already noted by Levy and by Trey; in presence of hydrogen chloride, however, it was found to stimulate the catalytic action of the acid. In accordance with the author's theoretical conceptions, the addition of a trace of a weak acid (N/300 succinic or acetic acid) was found to produce a slight retardation, although larger quantities of the acid accelerated the change. The same issue contains a paper by Kuhara and Komatsu on a series of isomeric phenyl-phthalimides. Two compounds previously described could not be prepared again, but, in addition to the ordinary stable, colourless phthalimide, the authors obtained a colourless isomeride melting at 83–84°, which readily passed over into the stable form, and a yellow compound melting at 125–126°, which could not be transformed. The isomerism of the derivatives of phthalic acid is undoubtedly one of the most important of the cases awaiting investigation, and further work in this direction is much to be desired.

THE October issue of *Pearson's Magazine* contains a further instalment of Lieut. Shackleton's narrative entitled "Nearest the South Pole." In the same number is also to be found an illustrated article dealing with oak galls.

MM. A. HERMANN ET FILS, of Paris, have published a second French edition of the third part of Mr. W. Rouse Ball's "Mathematical Recreations and Essays." The volume includes the chapters on astrology, hyper-space, and time and its measurement, together with additions by MM. Margossian, Reinhart, FitzPatrick, and Aubry. The translation is from the fourth English edition, and its price is 5 francs.

IN the Proceedings of the American Academy of Arts and Sciences (xliv., 25) Messrs. Gilbert W. Lewis and Richard C. Tolman discuss the principle of relativity, and the system of non-Newtonian mechanics required to maintain such fundamental conservation laws as that of energy and to reconcile them with the experimental results of Michelson and Morley and of Bucherer.

A SERIES of volumes on the history of science has been arranged by the Rationalist Press Association, and will be published by Messrs. Watts and Co. The first two volumes are "The History of Astronomy," by Prof. George Forbes, and "The History of Chemistry" (vol. i., from earliest times to 1850 A.D.), by Sir T. E. Thorpe. Among the authors who will contribute to the series are Dr. J. Scott Keltie (geography), Mr. Horace B. Woodward (geology), Prof. L. C. Miall (biology), and Dr. A. C. Haddon (anthropology).

THE Railway Department of the Cape Government has issued a second edition of its official guide-book under the title "Cape Colony To-day." The book runs to 280 pages, is profusely illustrated, and provides an admirable account of the distinguishing characteristics of the districts described. For the convenience of tourists who wish to explore Cape Colony thoroughly nine tours have been mapped out, and particulars are given of the chief towns and other interesting places *en route*. The principal industries dealt with are fruit and grain growing and ostrich farming in the western province; sheep, goat, and ostrich farming and fruit growing in the midland districts; and the cultivation of maize. Every sort of information likely to be of service to the traveller is to be found in the book.

A COPY of the report for 1908–9 of the council of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne has been received. The society is to be congratulated upon receiving, by the will of the late Mr. George E. Crawhall, a legacy of 6000*l.* to be invested for the benefit of its funds. The legacy was most opportune in view of the many financial needs of the society, and it is to be hoped that the council's appeal for donations to enable the cost of maintenance of the Hancock Museum at Newcastle-upon-Tyne and of printing the society's Transactions to be met will be responded to generously. The curator's report on the museum shows that a complete overhauling and re-installation of the fishes in the zoology department has been effected, and that numerous valuable specimens have been presented to different sections of the museum.

A SIXTH edition of Mr. Herbert M. Wilson's "Irrigation Engineering" has been published by Messrs. Chapman and Hall, Ltd., in this country, and by Messrs. John Wiley and Sons in America. The fourth edition of the work was reviewed at length in these columns on January 28, 1904 (vol. lxix., p. 291), and it will suffice to mention some of the distinguishing characteristics of the present edition. The book has been re-written almost entirely, and brings up to date the remarkable progress made in construction by the Reclamation Service of the United States. Much old matter has been eliminated, and a large amount of new text and eighty new illustrations, representative of more modern designs for irrigation works, have been introduced.

WE have received the third part of the first volume of the Journal of the Municipal School of Technology, Manchester. An explanatory note points out that the journal was established to record the original scientific work done in the school by members of the teaching staff or by students. Such work has accumulated so rapidly, however, that it has been decided to print in abstract only, or in some cases the titles only, of all the work published previous to 1908 which has not appeared in the journal already. The papers for 1908 are to be printed in full. The present issue contains the paper by Mr. J. Prescott on the figure of the earth which appeared in the *Philosophical Magazine* of October, 1907, and abstracts of papers from the mechanical engineering, the physics, the electrical engineering, and the chemistry departments. It is noteworthy that the excellently produced periodical was printed in the photography and printing crafts department of the school.

OUR ASTRONOMICAL COLUMN.

HALLEY'S COMET.—In a communication to No. 4263 of the *Astronomische Nachrichten* (p. 319, October 13), Prof. Millosevich states that the photographic observations of Halley's comet made on September 14 show that the elements already published need very small corrections, and that, according to his calculations, perihelion passage should occur at 1910 April 19·2d. (Berlin M.T.) ±0·5d.

Father Searle, director of the Brooklands Catholic University Observatory (U.S.A.), finds, from the Mount

Hamilton observations of September 12, 13, and 14, that perihelion should occur at 1910 April 18·63 G.M.T., and that the nearest approach to the earth should take place on 1910 May 19 at a distance of about 0·14, *i.e.* about 13,000,000 miles. Further, he points out that on May 18·14d. (G.M.T.) the earth and comet will be in heliocentric conjunction in longitude, the longitude being 236° 48′; the heliocentric latitude of the comet will then be −7′, so that, according to the present elements, no actual transit of the comet over the sun's disc will occur, but a slight change in the elements might produce one. "At any rate," he says, "it seems highly probable that we shall on May 18 be inside the tail."

In a communication to the *Times* (October 25), Prof. Newall announces that he observed the comet, visually, with the 25-inch refractor, power 214, on October 21. The magnitude was about 14·0 or 14·5, and the faint nebulous patch had neither stellar nucleus nor definite borders; the diameter was estimated as 10 or 12 seconds of arc.

At the previous apparations, in 1759 and 1835, the comet was first seen 77 and 102 days, respectively, before perihelion; Prof. Newall's observation was made about 180 days before the calculated perihelion passage of 1910, but he points out that this does not necessarily mean that the comet is so much brighter at the present apparition, for he would probably not have detected it had he not known its exact position as indicated by the previous photographic observations.

QUANTITATIVE MEASURES OF THE OXYGEN BANDS IN THE SPECTRUM OF MARS.—In Bulletin No. 41 of the Lowell Observatory Prof. Very describes the methods by which he measured the relative strength of the B, oxygen, band in the spectrum of Mars, and discusses the results in their relation to the presence of, and quantity of, oxygen in the planet's atmosphere.

As Prof. Very points out, the B band is normally so intense, by the absorption in the earth's atmosphere, that only by a method capable of the minutest accuracy could it be expected that any slight extra intensification, due to the Martian atmosphere, would become measurable. He claims that, over a long series of measures, his improved spectral-band comparator is capable of measuring this added intensification. Briefly, although a visual examination shows no increase of intensity of B in passing from the spectrum of the moon to that of Mars, the comparator measures are surprisingly concordant in showing a positive value, in favour of Mars, several times greater than the probable error; B, in the spectrum of the planet, is 15 per cent. stronger than in the lunar spectrum, and the probable error is 1·8 per cent. There is, as would be expected, a considerable variation among the individual measures, but no contradictory results.

STARS HAVING PECULIAR SPECTRA: NEW VARIABLE STARS.—Harvard College Observatory Circular, No. 143, contains a list of seven stars exhibiting peculiar spectra, and twenty-eight stars shown to be variable. For each star the position, for 1900·0, is given, and the class of spectrum indicated, whilst a series of notes summarises the observations. Some of the variables show a long range of magnitude, in one case amounting to 5·0.

Circular No. 151 is a similar publication announcing the discovery of twenty new variable stars in the Harvard map No. 49. It also describes a star in Taurus, at

R.A. = 5h. 43m. 12s., dec. = +19° 2·0′,

which varies more than five magnitudes, and exhibits a light-curve of the rare R Coronæ Borealis type. Long periods of normal brightness are followed by sudden diminutions over a wide range, the normal brightness being 10·2 and the minimum fainter than 15·5.

THE NATAL GOVERNMENT OBSERVATORY.—Mr. Nevill's report for the year 1908 deals chiefly with the meteorological observations, which, with the time service, form the chief work of the observatory, but it is noted that the large equatorial telescope was overhauled and repaired, and some observations were made with it by Mr. Hodgson. Among these was a new series of lunar photographs, for the determination of the real libration, and some sketches of the surface configurations of Mars, Jupiter, and Saturn.

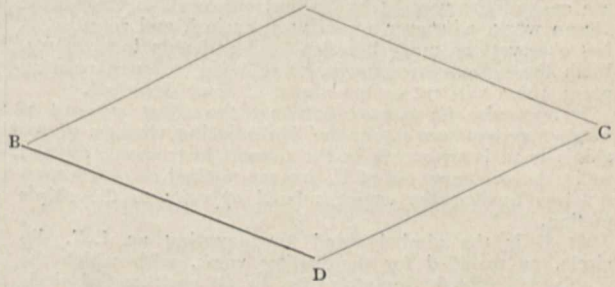
FIRST MAGNETIC RESULTS OBTAINED ON THE "CARNEGIE" IN THE NORTH ATLANTIC.

THE non-magnetic yacht the *Carnegie*, engaged in a magnetic survey of the oceans under the direction of the Department of Research in Terrestrial Magnetism of the Carnegie Institution of Washington, left Brooklyn, New York, on her first cruise, August 21, and proceeded direct to Gardiner's Bay, Long Island. Here several complete swings of the vessel were made with both helms in order to test the instruments, train the observers, and, above all, to determine whether actual non-magnetic conditions had been secured at the various positions of the instruments. These tests resulted most satisfactorily, not only proving the absence of deviations in the three magnetic elements (declination, dip, and intensity), within the errors of observation, at all observation positions, but also showing that with the instruments installed and the methods of observation employed a high degree of accuracy can be obtained.

Summary of Swings at Gardiner's Bay, Long Island, New York, August 31 to September 2, 1909.

Ship's head	West declination		Dip	Horizontal intensity in C.G.S. units	
	M.C.	Deflector	North	L.C.D.C.	Deflector
	Position A	Position C	Position B	Position B	Position C
N.	11°·41	11°·41	72°·02	0·1823	0·1830
N.E.	11·39	11·52	72·12	0·1823	0·1824
E.	11·45	11·48	72·11	0·1823	0·1830
S.E.	11·39	11·29	72·11	0·1826	0·1824
S.	11·34	11·41	72·09	0·1825	0·1831
S.W.	11·33	11·28	72·04	0·1824	0·1827
W.	11·32	11·40	72·08	0·1822	0·1823
N.W.	11·46	11·42	72·18	0·1823	0·1822
Mean ...	11·39	11·40	72·09	0·1824	0·1826

Only one who has had experience both in the observations and reductions of magnetic elements determined at sea can appreciate the full significance of these results and can realise the advance made.



The above diagram will assist in the interpretation of the figures given in the above table, and at the same time make clear the general arrangements of the various instruments and the methods used. Consider the plane ABCD to be a vertical section through the four instrument positions and the fore and aft line of the vessel. Position A is on the bridge above the deck or chart-house, B is in the forward observatory, C in the after observatory, and D at the middle point of the chart-house, vertically below A. The sides of the parallelogram are about 13½ feet.

At A is mounted the standard compass, one of a new type invented and constructed by the Department of Terrestrial Magnetism, and called the "marine collimating compass"; it will be found described in the March (1909) issue of the journal *Terrestrial Magnetism*. The basis of

the instrument is a Ritchie 8-inch liquid compass with the card, however, removed, and an optical collimating system with scale introduced, enabling the observer to note the arc of motion of the magnet system *while sighting on the sun or star*, hence knowing precisely to what part of the arc the stellar azimuth applies. In all forms of compass azimuth circles hitherto used, the magnetic azimuth of the celestial body must be taken from whatever point the card in its oscillations to and fro has momentarily reached. In brief, practically the same method of observations can now be used at sea as on land, where the magnetometer circle would be set to some convenient point on the magnet scale and then scale readings taken of the positions of the magnet during the interval of observations. The angle is next determined between the circle setting and some mark, or the true meridian, and the declination is finally deduced. Similarly with the marine collimator compass. The angle (say, middle of scale) between the magnet and some celestial body, as the sun, is read with a pocket sextant to the nearest minute of arc at a given time, and then scale readings of magnet and of watch are taken. With the aid of the time readings, the motion of the sun during the interval of observation is taken into account, and the true azimuths determined, whereas the scale readings give the varying positions of the magnet system.

With this instrument, therefore, one is almost entirely independent of the yawing and rolling of the ship, making it possible still to get satisfactory results when with all other azimuth circle devices hitherto used at sea observations would be wholly impossible, or at least very uncertain.

In five to ten minutes a value of the magnetic declination is now obtained possessing an accuracy attainable with previous instruments only by most careful observation and by laborious repetitions extending over a half-hour or more to eliminate the motion of the card. Thus not only has the accuracy of declinations at sea been increased, but, what is equally important, the time has been reduced and the possibility of getting useful results in all kinds of seas greatly extended.

Furthermore, sufficient attention has not always been paid in previous ocean magnetic work to a proper control of constants. Thus, *e.g.*, with the compass azimuth circles, as usually constructed, there are movable parts subject to wear, such as the axes of mirrors or of prisms and of the azimuth circle on the bowl. The wearing of these parts may easily bring about the same effect as though the compass were not mounted in the fore and aft line, *i.e.* introduce a quantity A not due necessarily to the ship's magnetism, but to instrumental error, which is likely to vary with extent of use of azimuth device. To control such errors, all instruments were invariably dismounted in the case of the vessel (the *Galilee*) employed in the Pacific Ocean work, whenever a port was reached, and corresponding observations made between land and ship instruments. With the present instrument, there being no such wearing parts, there will not be the source of error described.

It may also be pointed out that the *effect of drag of magnet* system moving in the liquid during changes of the ship's head is overcome in the present instrument, as well as in the one mounted at C, for the method of observation involves turning the compass bowl *opposite* to the ship's motion.

At B is the gimbal stand for mounting an L.C. dip circle, as modified for the *Galilee* work, with which the dip is determined absolutely (*i.e.* in all positions of circle and needle, inclusive of reversal of polarity by an electric coil) with two regular dip needles and again by the method of deflections, and total intensity is obtained using two deflecting distances.

At C is a Ritchie liquid compass provided with an improved azimuth circle and a deflecting attachment, both designed and made by the Department of Terrestrial Magnetism. With this instrument declinations are obtained, and also the horizontal intensity of the earth's magnetic force, by the method of deflections independently with two deflecting magnets, the magnetic moments of which are controlled from time to time by shore observations whenever the vessel is in port, and using two deflecting distances. In these deflection observations the yawing of the ship, or the changes in the lubber-line from which the deflection angles are counted, is controlled by the recorder stationed at D, who reads the ship's head by a spare Thomson dry compass. The same kind of deflecting device by which the deflecting magnet is brought at right angles to the axis of the deflected card, thus admitting of the simple sine-computation formula, is likewise attached to the marine collimating compass at A. In the latter case the angle between deflected magnetic system and the sun (or true meridian) is read with a pocket sextant, thus making one entirely independent of the yawing of the ship.

The declinations obtained at C are intended chiefly as some control against any gross blunders which may be made at A; for a fairly smooth sea they compare favourably with those got at A, but in rough seas the great superiority of the A results is very evident.

In brief, then, the scheme of observations, whenever fully carried out, will yield the following determinations in about one hour's time by independent observers, with different instruments, and at different positions on the vessel:—

At A.—Declinations (also horizontal intensity when a celestial body is long enough visible to permit of full sets of deflection observations).

At B.—Two values of dip by the regular absolute method, and two values of total intensity and of dip, using two deflecting distances.

The horizontal intensity is determined by computation from the dip and the total intensity.

At C.—Two values of horizontal intensity independently with two magnets, and using each time two deflecting distances; also, whenever possible, magnetic declinations. D, as above described, is simply accessory to C, and does not furnish any direct result.

It is thus seen that an effective control is obtained for each magnetic element, and it is for this purpose a great gain indeed that it is now possible to compare *at once* the values of horizontal intensity, for example, got at B and C without first waiting until the deviations are well determined, as has hitherto been the case in all previous vessels engaged in magnetic work—even on the *Galilee*, which, before the *Carnegie*, had the smallest deviations of any ship.

Besides the great improvement resulting from having a non-magnetic vessel, and from the perfection of the instruments themselves, the conditions and opportunities for observing have also been materially bettered on the *Carnegie*. Thus the instruments at B and C are under shelter, being mounted in observatories with revolving domes and movable slides, permitting of both magnetic and astronomical observations, with full protection to the observer and instrument from wind and weather.

Outstanding Difficulties.—These are chiefly due to meteorological conditions and the state of the sea. Thus in the absence of sun or star no magnetic declinations can be obtained, though dip and intensities may be got even in a pouring rain, because of the introduction of the sheltering observatories. It is hoped that some instrument based on the gyroscope compass may be soon perfected having the desired accuracy, with the aid of which the direction of the magnetic needle may be referred to an invariable plane to be controlled whenever a celestial body becomes visible.

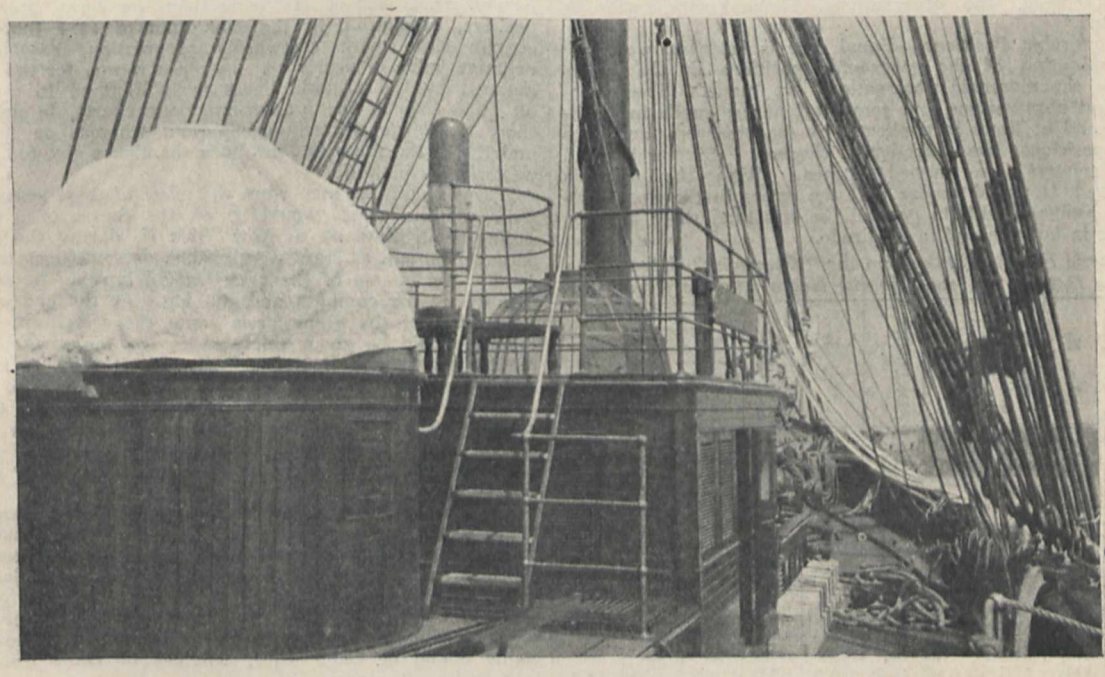
Were one to wait for a calm or a fairly smooth sea it would occur quite frequently that no magnetic results would be forthcoming. In fact, on the entire recent October passage of the *Carnegie* from St. John's, Newfoundland, to Falmouth, England, there was not a single day which would fall in the usual category of favourable days of observation, but, instead, on nearly every day there was a gale, the sea was rough, the vessel yawed through an angle of 10° or more, and rolled through an arc of 20° to 30° and more, and yet observations were secured on every day except one. That utilisable magnetic results have still resulted under such very adverse conditions is due to the perfection of the instruments, the cutting down of time required for observations to get a desired degree of accuracy, thus reducing to a minimum the condition of steadiness of ship, and, of course, to the skill of the observers. Still further improvements are being striven for with regard to independence of steadiness of ship.

It is thus seen that while the endeavour is steadfastly held in mind to measure the magnetic elements at sea

with every possible precision, the improvements made, and yet to be made, are along the line of reduction in time required to achieve the desired result—in other words, towards simplicity. With proper instrumental means and methods it need not require any more time to make accurate observations than to get indifferent results with instruments not adapted to the conditions to be met.

As a proof of this is given below the table of results of the work on board the *Carnegie* from September 1 to October 18, or in about six weeks' time. After the tests in Gardiner's Bay referred to above, the vessel proceeded, under the command of Wm. J. Peters, to New London, Connecticut, to have some slight alterations made. She left this port on September 11 bound for St. John's, arriving there September 25. Here the director rejoined her, having left the vessel in Long Island Sound to attend the meeting of the British Association at Winnipeg, Canada.

After the necessary shore observations, the *Carnegie* set sail from St. John's on October 2 direct for Falmouth, England, arriving there on October 14, having had favourable winds. Owing to the lateness of the season the Hudson Bay cruise for this year had to be abandoned.



Deck view of the *Carnegie*, showing the chart house with Marine Collimator (A in diagram) in the middle and the two observatories. The forward one is uncovered, and inside it position B of the diagram, where the L.C. Dip Circle is mounted; inside the after observatory (the covered one) is mounted the Deflector and Compass (Position C).

After the completion of the harbour and shore observations at Falmouth, the *Carnegie*, continuing under the command of Mr. Peters, will proceed to Madeira, and will return early next year to New York *via* Bermuda, the director returning to Washington.

Personnel.—Besides the director of the department and the commander of the vessel, the scientific and navigation staff is composed as follows:—C. E. Littlefield, sailing master; J. P. Ault, E. Kidson, R. R. Tafel, observers; Dr. C. C. Craft, surgeon and observer; and D. F. Smith, chief engineer. The ship's *personnel* includes, furthermore, two watch officers, two cooks, eight seamen, and one mechanic.

Auxiliary Propulsion.—Of considerable interest in marine circles, aside from the magnetic work on board this vessel, are the experiments being made in the perfecting of a producer-gas engine for marine propulsion. Such a plant—and an almost entirely non-magnetic one—is aboard the *Carnegie*, of 150 horse-power, sufficient to drive her at six knots' speed in calm weather. This engine has already proved a useful adjunct to the vessel's equipment, facilitating the entering and leaving of ports, and such tests as were made at Gardiner's Bay requiring swinging of the vessel. The installation is in the charge of the chief engineer, Mr. D. F. Smith, who has had both theoretical and practical experience with gas engines. Mr. Carl Smith, an acknowledged gas-engine expert of the technological branch of the United States Geological Survey, is consulting expert in connection with this work. Should this type of engine be made a practical success for marine purposes, even though it be but for auxiliary uses, it will be a valuable achievement, being the most economical form of motor now employed.

The Magnetic Results.—In submitting now the magnetic results obtained to date, it should be stated that the computation and revision of results goes on apace on board with the observational work, not only that possible errors may quickly be detected, but also that the results may be made known promptly. It is the intention, hereafter, to publish the results at intervals of about three months.

Accuracy of Magnetic Results.—In general, the declinations given may be taken as correct within 0·1°, and only in but a few instances, when the conditions of sea were unusually bad, will the error be 0·2°; under favourable conditions the observation error in declination with the marine collimating compass for the mean result will be about ±0·05° (see the Gardiner's Bay results). About the same statement as made for the declination applies to the dip. The horizontal intensities, as at present given, may be assumed correct within 1 unit in the third decimal for the severe conditions encountered on the greater part of the cruise thus far; for fairly good conditions of the sea the error need not be more than 5 in the fourth decimal, and may be made less, as shown by the Gardiner's Bay work.

In making these preliminary statements, it should be remarked that every possible source of error is considered—in other words, *absolute* accuracy, not relative accuracy, is meant. For example, when it is declared that, given fairly good conditions, it is possible to get the dip on board the Carnegie within 0·05°, *i.e.* within three minutes *absolutely*, this means more than may at first appear. Thus dip circles—especially ship dip circles—have instrumental corrections exceeding frequently the relative error of observation. Accordingly, the dip circle on the *Carnegie* has been compared, not only with various observatory dip circles, but also with an earth inductor at Washington, for the range of dip from +88° to −60°. Further control will be had at the various ports of call during the progress of

the work. This serves as an illustration of the care required and being taken, not only with this form of magnetic instrument, but with every instrument used aboard.

We have preferred to underestimate our absolute accuracy rather than to overestimate it. In any case, it may be said that the magnetic elements are now being obtained on the *Carnegie* with sufficient accuracy, not only for practical demands, but also for purely scientific ones.

Were we able to choose the time to observe and wait for fairly smooth sea, the magnetic elements could be determined at sea with an accuracy practically the same as in the determinations for land magnetic surveys.

Diurnal Variation Corrections.—No corrections for diurnal variation need, in general, be applied. The attempt is being made to get the magnetic elements at such times of the day when these corrections are small or are of the order of the error of observations. Thus, for example, the most favourable condition for the declination work is when the sun is low, *i.e.* early in the morning or late in the afternoon, and at these times the diurnal variation corrections are small and frequently of opposite sign. Should there be evidence of magnetic disturbance during the observations, or as may appear later from observatory records, the observations, if necessary, will be rejected.[1]

Geographic Positions.—Equal care is bestowed upon the determination of the geographic positions of the points where the magnetic observations are made. The astronomical observations and computations are made in duplicate, and at times in triplicate, by the observers, and thus the positions are effectively checked. Six well-tested chronometers are carried aboard. With the methods followed, it would appear that the errors in the final positions assigned will, in general, be less than three minutes of arc in latitude and in longitude.

Magnetic Results obtained on the "Carnegie," September 1 to October 18, 1909, in the North Atlantic Ocean.

No.	Lat. N.	Long. W. of Greenwich	Date, 1909	Declination W.	Dip N.	Hor. Int. C.G.S.	Corrections of Variation Charts		
							British	U.S.	Ger.
	°	°		°	°		°	°	°
1	41·1	72·2	Sept. 1	11·4	72·1	0·183	+0·4	+0.5	+0·2
2	41·0	71·1	13	12·3	72·0	0·182	+0·6	+0·3	+0·6
3	40·9	70·4	14	12·9	—	—	+0·8	+0·9	+0·7
4	40·7	69·4	14	12·8	71·7	0·185	+0·22	+0·4	+0·4
5	40·9	68·9	15	13·9	71·9	0·182	+0·8	+0·4	+0·7
6	40·9	68·4	16	14·4	—	—	+0·8	+0·3	+0·6
7	41·3	66·4	17	16·2	71·9	0·181	+0·8	+0·3	+0·9
8	42·0	61·1	20	20·2	—	0·177	+1·1	+0·7	+0·8
9	42·5	61·2	21	20·8	—	0·176	+1·3	+0·6	+0·6
10	42·8	60·8	21	21·4	72·5	0·173	+1·4	+0·9	+0·4
11	43·8	58·9	22	23·7	72·7	0·171	+1·5	+0·7	+1·3
12	45·5	55·7	23	—	72·7	0·169	—	—	—
13	47·3	52·6	25	—	73·5	0·158	—	—	—
14	47·6	52·7	28	29 75	73·5	0·159	0·0	0·0	0·0
15	47·8	51·4	Oct. 3	30·4	—	—	+0·2	−0·2	+0·9
16	48·2	50·4	3	—	73·5	0·157	—	—	—
17	48·4	48·0	4	31·8	—	—	+0·4	+0·3	+1·2
18	48·5	47·7	4	31·8	73·0	0·161	+0·2	+0·1	+1·1
19	48·7	46·5	5	31·8	—	—	−0·1	−0·2	+1·1
20	48·9	45·5	5	32·1	72·5	0·161	−0·1	−0·3	+1·5
21	49·6	37·5	7	—	71·2	0·168	—	—	—
22	50·3	32·1	8	30·2	70 7	0·171	−0·4	−0·4	−0·4
23	50·6	28·8	9	29·0	—	—	−0·7	−0·8	−0·7
24	50·6	24·0	10	26·6	—	—	−0·6	−0·9	−0·8
25	50 6	22·2	10	—	69·2	0·174	—	—	—
26	50·5	19·2	11	24·5	—	—	−0·2	−0·3	−0·3
27	50·3	17·2	11	22·9	68·3	0·180	−0·9	−0·8	−0·9
28	49·9	11·9	12	20·3	67·4	0·185	−0·7	−0·6	−0·5
29	49·6	9·3	13	19·7	—	—	+0·2	+0·1	+0·2
30	49·5	7·5	13	18·6	66·3	0·190	0·0	−0·1	−0·1
31	50·0	5·0	14	17·5	—	—	+0·1	−0·1	−0·2
32	50·1	5·0	18	17·8	66·5	0·187	+0·2	+0·2	+0·1

No. 1 in Gardiner's Bay; No. 14 at St. John's, Newfoundland; No. 32 in Falmouth Bay.

[1] *Magnetic Storms and Northern Lights.*—It so happened on board the *Carnegie* that no magnetic observations were in progress during the severe portions of the magnetic storms of September 25 and October 18–19. No Greenwich time signals could be obtained at St. John's from Heart's Content on the morning of September 25 on account of heavy earth currents. Northern lights were seen between 8 and 10.30, local apparent time, of the evening of September 21 in latitude 43° N. and longitude 60½° W. of Greenwich. A glow of white light with occasional streamers extended upward about 10° above the horizon from a low bank of cumulo-stratus clouds. The display was in the magnetic north. The evenings of September 22, 23, 24, and 25 were cloudy or foggy.

Corrections of the Present Magnetic Charts.—The table requires no explanation other than is already given in the headings, with the exception of the last three columns, which exhibit the quantities to be added to or subtracted from the declinations scaled from the lines of equal magnetic declination ("variation of the compass"), first, as given by the British Admiralty chart, 1907; next, by the United States Hydrographic Office for 1910; and, lastly, by the Deutsche Seewarte for 1905.[1] In all cases the values scaled from the charts have been referred to the present time with the aid of the secular variation corrections as given on the respective charts. It will be seen that, in the case of each chart, the corrections are usually less than 1°, and, considering the miscellaneous data at the disposal of the makers of the charts and the uncertainty of the secular variation reductions, the general correctness of the charts is most gratifying.

However, one fact, revealed by the prevalence in sign of the quantities appears to be of sufficient practical importance to require attention. The data given in the table apply pretty closely to the tracks followed by the Transatlantic steamers between New York and England.

Along the portion from New York to a point somewhat beyond Sable Island the corrections for each chart are positive, amounting in the maximum to 1½°; they then change sign, with eastwardly progression, reaching a negative value of nearly 1°. In other words, for the track pursued by the Atlantic liners from England to a point off Sable Island, the present magnetic charts, in general, show too large westerly declination, whereas on the remainder of the route to New York the charts give too small westerly declination.

It can readily be seen what the effect of these systematic errors of the charts would be on the course of a vessel sailing from England to New York if, during the entire passage, no sun or stars were visible, as sometimes occurs, so that the course of the vessel would have to be shaped entirely by the compass and the log. At the end of the 2000 miles of the great circle route the vessel, off Sable Island, would be about thirty miles too far *north* of her regular track, and if the set of the current were in the same direction the vessel would easily be exposed to shipwreck. From Sable Island to New York the effect of the chart errors, being reversed in sign to what they were before, would be in the opposite direction, *i.e.* the vessel would be put out of her true course in a southerly direction.

For a vessel going eastward the effects are just reversed; hence on the course from New York to Sable Island the tendency of the chart error would be to set the vessel to the northward, hence again towards the source of danger; thereafter the vessel would be set to the southward of her outlined course. So that, if proper allowance were not made, a captain would have his vessel turned off towards Sable Island or Cape Race, whether he came from the east or from the west.

It appears to be known to some captains, at least, that there is some such systematic change which, judging from conversations had with them by one of the present writers (Bauer), during various Atlantic voyages, is ascribed by them to a systematic change in their ship deviations. Two captains have told him, independently of each other, that after their compasses had been carefully adjusted they have noticed by repeated observation a systematic change in the deviations, which *reversed* in sign when Sable Island was passed. The effects would be opposite for the eastward and the westward cruises. The deviations referred to by these captains are the differences between chart values and those observed with their adjusted standard compasses; hence they are not pure deviations, but are the sums of ship deviation and chart error. The work of the *Carnegie* has now proved that the cause of the systematic change and reversal of ship deviations encountered by these painstaking captains was due, in part at least, to systematic errors in the variation charts.

The corrections for the chart of the lines of equal magnetic dip (British Admiralty Chart of 1907 and the Deutsche Seewarte of 1905) are generally less than ½′, being sometimes plus and sometimes negative.

The lines of equal horizontal magnetic intensity as laid

[1] The latest chart of the Deutsche Seewarte is not at present to hand.

down on the British Admiralty Chart for 1907 are in error by amounts reaching 16 units in the third decimal C.G.S., and those of the Deutsche Seewarte for 1902 (the most recent chart not being available to us just now) require corrections running up to 12 units in the third decimal on the values obtained by the *Carnegie*. A part of this error is, of course, due to secular variation, but the major portion appears to be due to defective data. For both charts there are five negative corrections, amounting in the maximum to 4 units in the third decimal, four zero values and thirteen positive ones for the "B.A." chart, and two zero and fifteen positive corrections for the "Seewarte" chart. On the average for the Atlantic, from Long Island to Falmouth, the chart values are too low by about 1/45th part of the value of the force, even at times amounting to 10 per cent. to 20 per cent. In the Pacific Ocean the intensity charts gave, in general, too high values by about 1/25th part.

Since the above was written the *Carnegie* has been swung in Falmouth Bay, observations of the three magnetic elements (declination, dip, and horizontal intensity) being made on eight equidistant headings. The mean results of the entire swing are in excellent agreement with what would be deduced from Rücker and Thorpe's magnetic charts of the British Isles applying secular variation corrections as deduced from the records of the Falmouth Magnetic Observatory. The declinations and dips agree within two or three minutes, and the horizontal intensity within 1/2000th part. This again proves that there are no deviation corrections of whatever nature to be applied to the *Carnegie* results; also that the instrumental constants have been well determined. We have here also a satisfactory proof that if the distribution of magnetism is uniform, as appears to be the case here, the sea values, upon careful measurement, will be found in agreement with the shore values.

L. A. BAUER.
W. J. PETERS.

THE ANALYSIS OF SOUNDS USED IN SPEECH.

THE characteristics of the simpler sounds which form the elements of speech have been studied by many physicists. At first, attempts were made to reproduce the vowel sounds synthetically; Helmholtz achieved noticeable successes in this endeavour, but by themselves synthetical methods can never be quite satisfactory, since it is necessary to prove that the ear does not possess properties similar to those possessed by the eye; it is well known that two mixtures of light may produce identical effects on the eye, although the component waves may be quite different in the two cases.

Many attempts have been made to analyse complex sounds, but the results obtained up to the present have not been quite conclusive. Dr. Erskine-Murray used a thin membrane stretched slackly over the small end of a conical tube; a light mirror was adjusted so that it was rocked to and fro by the motion of the membrane, and a beam of light was reflected from this on to a revolving mirror and thence on to a screen. Such an arrangement is very sensitive for sounds of low pitch, but it is mechanically unsuitable for analysing sounds of high frequency. Hermann, McKendrick, and Bevier have attacked the same problems by analysing phonograph records, and have obtained much useful information; but there is small reason to suppose that a phonograph record, however good it may be, affords an exact equivalent to human speech.

For some time past Mr. G. Bowron, of 57 Edgware Road, has devoted attention to the construction of an oscillograph which projects on a screen a curve representing the sounds produced by a gramophone; a brief notice of this oscillograph was given in NATURE of May 21, 1908 (vol. lxxviii., p. 69). The curves obtained are very instructive, and they appear to possess as much detail as those obtained by the elaborate method of Prof. McKendrick; but the problem of the analysis of the sounds used in speech can scarcely be solved in this way.

The best curves representing vowel sounds have been obtained by Mr. Duddell; some of these are published in the Journal of the Institution of Electrical Engineers (vol. xxxix., No. 186, 1907, pp. 545–6). They were obtained by speaking into a "solid-back" telephone transmitter, and transmitting the periodic current obtained thereby through the high-frequency electrical oscillograph invented by Mr. Duddell. The regularity of these curves is very striking; a perfectly definite curve corresponds to each vowel sound, and with some practice it would be possible to decipher a telephone message by inspecting the curve which corresponds to the telephone current. It may be mentioned, in passing, that the analysis of the sounds which constitute speech is now acquiring commercial importance in connection with the problem of telephone transmission.

Mr. Bowron has constructed an acoustic oscillograph intended to show the vibrations comprised in ordinary speech; but although this gives some interesting information, the curves obtained are not nearly so good as those obtained by Mr. Duddell. The arrangement used is somewhat like that due to Dr. Erskine-Murray, but the slack membrane is replaced by a ferrotype telephone diaphragm. In practice it is found that Mr. Bowron's oscillograph does not give good curves for sounds of low pitch; this is due to the fairly high frequency of the natural vibrations of the diaphragm. It has been pointed out by Mr. A. Campbell (Jour. Inst. Elec. Engineers, vol. xxxix., No. 186, p. 533) that even a microphone transmitter has certain definite free periods, and that sounds of the corresponding pitches are greatly reinforced. Mr. Campbell's experiments in proof of this are worthy of mention here. A solid-back microphone is put in circuit with a battery of 6 volts or 8 volts and the primary circuit of a fair-sized spark coil. The secondary of this coil is connected to a reflecting electrostatic voltmeter reading up to 10 volts. The deflections of the voltmeter afford a sensitive indication of sounds received by the microphone. If the nearly pure note of a stopped organ-pipe be sounded, a deflection of the voltmeter is produced, and if the pitch of the note be gradually raised the spot of light rushes off the scale when the note attains certain definite frequencies. This arrangement might be used with advantage in cases where measurements of the intensities of sounds are required.

There can be little doubt that much remains to be done in connection with the analysis of the sounds used in speech. Thus the curve obtained by Mr. Duddell for the *oo* sound in "coo" scarcely differs from a sine-wave curve; a slight alteration of the mouth introduced the octave of the fundamental vibration. According to the accepted theory of vowel sounds, each vowel is distinguished by the reinforcement of those partials which lie near to certain definite pitches. The question could be answered definitely if we possessed a diaphragm which would vibrate indifferently for all pitches; and since the drum of the ear does this, it may be hoped that we may be able to realise the conditions necessary to the solution of the problem.

EDWIN EDSER.

HEAT TRANSMISSION.

A PAPER on heat transmission was read by Prof. W. E. Dalby before the Institution of Mechanical Engineers on Friday, October 15. The object of the research was to place before the members a general view of the work which has been done relating to the transmission of heat across boiler-heating surfaces, and in carrying this out more than 500 papers have been read and abstracts of the more important prepared.

In a furnace heat is transmitted by three methods simultaneously, viz. radiation, convection, and conduction. It is extremely difficult to analyse the results of experiments, so that the heat transmitted by each of these methods may be stated separately. Formulæ of simple type have been devised to express the results of definite sets of experiments; the application of such formulæ should be strictly limited to cases in which similar conditions prevail and fall within the range of the original experiments.

In discussing radiation, the author gives Stefan's law

expressed in British thermal units radiated per square foot per hour as $16\times10^{-10}(T_1^4-T_2^4)$, where T_1 and T_2 are the temperatures of the incandescent gases and of the boundary respectively in degrees Fahrenheit absolute. This formula may be applied in order to find a theoretical upper limit to the quantity of heat radiated to the fire-box boundary on the assumption that the flame is actually composed of solid masses of incandescent carbon, and so follows Stefan's law. Thus, with flame and boundary temperatures respectively of 3000° and 800° F. absolute, the heat radiation is 129,600 British thermal units per square foot per hour. With temperatures respectively of 4000° and 800° the radiation amounts to 410,000 British thermal units, showing the rapidity of increase of radiation as the flame temperature rises. Stefan's law does not apply to cases where the gases are not incandescent.

In transmission by conduction and convection the heat-flow path from the interior of the mass of gas in the fire-box to a point in the interior of the mass of water is made up of the following parts:—the gaseous part from the starting point to the gas film clinging to the plate; the gas film itself; the surface of contact between the plate and the gas; the metallic plate; the surface of contact between the plate and the water; the water film; the water from the film to the point in the mass of water. To these must be added, for dirty plates, a layer of sooty deposit on the gas side and a layer of scale on the water side, on which there may also be a deposit of oily matter. There is evidence that 98 per cent. of the total "temperature" head is required in order to force the heat from the gas into the plate, the remaining 2 per cent. alone being required to transfer the heat from the plate to the water in the boiler. The presence of oily matter may raise the temperature difference between the hot side of the plate and the water from 68° F. to 550° F., depending on the nature and thickness of the greasy deposit. The thickness of the film of gas clinging to the plate is probably of the order of 1/40-inch, and accounts for the greater part of the resistance offered to heat transmission by the total path of flow. The water film clinging to the plate also contributes to the resistance, as convection currents cannot exist in it, and heat must be transferred across it by the conductivity of the water forming the film, which is known to be exceedingly small.

If these films be completely or partially destroyed, the head required to effect the heat transmission from the gas to the water across the plate will be considerably reduced. One of the most potent factors in disturbing the gas film is the velocity possessed by the moving gases. Most of the work in connection with heat transmission since the time of Rankine shows attempts to introduce a velocity factor variable into the expressions. Again, owing to the temperature gradient from the centre of the flue gases to the boundary, the efficiency must increase with a decrease in the size of the flue within limits. Hence the hydraulic mean depth of the flue must form a factor. The importance of good water circulation lies in the fact that forcing water across the heating surface with a high velocity has the effect of breaking up the water film.

Notwithstanding the large number of researches bearing on the subject of heat transmission, there is a general absence of complete data regarding the actual phenomena occurring in a steam boiler when working under ordinary conditions of practice. For instance, no data exist which gives the temperature gradients at different parts of a boiler flue with accuracy. Researches have had little effect in modifying the general design of steam boilers, although the costly nature of these may be understood from a set recently made by the United States Geological Survey, costing 100,000 dollars. The author suggests that the institution might undertake a research in which steam boilers of different types under practical conditions may have all the elements of their working measured, together with temperature measurements for the purpose of establishing the temperature gradients at different parts of the heating surface. Such a research would be costly, but would be well worthy of the institution.

The paper contains elaborate indexes giving reference to all known work bearing on the subject; these will be extremely valuable to all interested in heat transmission.

THE ANTIQUITY OF MAN IN SOUTH AMERICA.

THE views held by Dr. Florentino Ameghino as to the antiquity of man in South America are based on the occurrence of split bones, and bones showing signs of having been cut, side by side with certain scoriaceous products, the "tierras cocidas" of Argentina. We are not as yet in possession of figures of the bones, and it may be presumed that they are regarded as of less importance than the baked and reddened earths. A lively controversy has arisen round the latter, and the question appears to be one that must be decided by the geologist rather than by the anthropologist.

Several series of deposits of Cainozoic age are recognised along the curving coast-line south of the mouth of the Rio de la Plata, past Mar del Plata, and away towards Bahia Blanca. The orientation of one of Dr. Ameghino's maps is unsatisfactory; but much topographical and descriptive matter will be found in his paper on "Las formaciones sedimentarias de la región litoral de Mar del Plata y Chapalmalán" (*Anales del Museo nacional de Buenos Aires*, tomo xvii., p. 343; published November 28, 1908). This, so far as the baked earths are concerned, is overshadowed by a memoir by Señor Outes, Dr. Ducloux, and Dr. H. Bücking, of Strassburg, issued on September 15 of the same year ("Estudio de las supuestas escorias y tierras cocidas de la serie pampeana de la República Argentina," *Revista del Museo de la Plata*, tomo xv., p. 138).

The two authors who have called in Dr. Bücking to their assistance review the question historically. The Araucanian formation, with the Monte Hermoso beds, which Florentino Ameghino prefers to regard as Miocene, is very generally placed by other authors in the Pliocene; but this does not affect the arguments of Outes and Ducloux. They point out that in 1865 Heusser and Claraz, in a paper published in French at Zürich, recognised cellular, and apparently volcanic, material in the lower part of the Pampas beds near Mar del Plata. More than twenty years later, in 1887, Florentino Ameghino gathered similar "escorias" at Monte Hermoso, 60 km. north-east of Bahia Blanca, and in 1889 described others from the neighbourhood of La Plata. These places are, of course, all remote from any volcanic vents that have so far been discovered.

Meanwhile, from 1874 onwards, the more obscure materials known as "tierras cocidas" were collected by Señores Juan, Carlos, and Florentino Ameghino from various places in the province of Buenos Aires, and the last-named writer claimed them as traces of ancient hearths, and as indicating man's antiquity in South America. The field was widened by other observers, and the typical specimens, with new ones personally collected, have now been investigated by Outes and Ducloux.

These authors make no claim to originality in rejecting the opinion of Florentino Ameghino. They quote the views of Steinmann in 1906 (p. 160 of their memoir) as to the andesitic nature of the scoriæ and baked earths, and they go back (p. 191) to Charles Darwin, who recorded, in 1851, the occurrence of pebbles of pumice on the surface of the raised terrace at Monte Hermoso. Darwin attributed these pebbles to the transporting action of ancient rivers, and pointed out how the rivers Negro and Chupat bring down volcanic pumice and scoriæ at the present day. Outes shows that such materials need not have been carried directly from the Andes, but may have been washed out of the detrital volcanic beds of the Araucanian formation, which is much older than the Pampas beds, and possibly than those of Monte Hermoso. The inclusion of vegetable remains in the scoriæ is held not to militate against their volcanic origin. Doering has urged the importance of laterisation in determining the characters of the red beds in the Lower Pampas series, and Outes (p. 194) quotes his views with approval as explaining many of the "baked earths." The elaborate chemical work of Ducloux (pp. 162–184) goes to show that the loess of the Pampas beds and the included scoriæ and "baked earths" have a similar chemical composition, and masses like volcanic scoriæ have been made artificially

by heating the loess at 1300° C. to 1350° C. The loess appears to contain abundant minerals that characterise volcanic lavas. The analyses given show a silica percentage of about 66 for the debatable scoriæ and "baked earths," and of only some 57 for the specimens of loess; but the latter loses some 13 per cent. of water, against 4 or 5 per cent. from the former materials. Ducloux opposes the suggestion of Ameghino that alkalies from the associated vegetation, burnt up with the loess, have entered into the composition of the scoriaceous matter.

H. Bücking's petrographic contribution (p. 185) should certainly have been illustrated. The writer, after microscopic examination, has no hesitation in classing the scoriæ as ordinary andesites. He traces volcanic lapilli in a "baked earth" from "Chapadmalal," and describes features in this material and in others sent to him which suggest a laterisation of volcanic dust.

Dr. Ameghino's paper, published in November, 1908, is largely stratigraphical. The beds of Monte Hermoso (p. 344) are here held to be much older than the Pampas formation, on account of their absolutely distinct fauna. If, then, man "or his precursor" is responsible for the "baked earths" found among them, the human race in South America may be traced back further than even Ameghino had previously supposed. We gather that this paper was well advanced before the issue of that by Outes and Ducloux, for Ameghino has since found it necessary to emphasise still further his views on the "baked earths" in a specially written memoir, in both French and Spanish, entitled "Productos piricos de origen antrópico en las formaciones neogenas de la República Argentina" (*Anales del Museo nac. de Buenos Aires*, tomo xix., p. 1; published February 17). He points out that the analyses of Ducloux merely show that the alleged volcanic cinders might have been formed from the fusion of the earth in which they lie, which is precisely the point that Ameghino wishes to establish. But it is not clear that the fused products (p. 17), prepared by Ameghino himself at 950° to 1000° C., have been submitted to microscopic examination, or that they exhibit the felspars and other associated minerals found by Bücking in the scoriæ.

Ameghino (p. 19) states that certain burrows formed as nests by the bee *Ancyloscelis analis* occur in the "baked earth," which must therefore have been burnt after the formation of the nests. Presumably this bee must also be transferred to the Miocene period if this argument is to be sustained. The paper concludes with a statement of how Outes and Ducloux failed to bring forward at Santiago, in Chile, a promised refutation of Ameghino's reiterated views. We may be happy, perhaps, if they consider that enough has now been said. While Florentino Ameghino does not seem to appreciate sufficiently the changes induced in rocks by laterisation, his critics have certainly not utilised to the full the resources of modern petrology. Probably some independent worker will ultimately arrive upon the scene, and we venture to think that he will confirm the views of Steinmann, Outes, and Ducloux. The widely distributed materials which have aroused so much discussion are hardly likely to add to our knowledge of the antiquity of man in South America.

G. A. J. C.

AGRICULTURE AT THE BRITISH ASSOCIATION.

IN view of the outstanding importance of agriculture in Manitoba, it was decided to concentrate attention on a few of the fundamental problems of the North-west and to discuss them as fully as possible both in the subsection itself and in joint meetings with other sections. Such joint discussions are particularly valuable, because the problems in agricultural science are highly complex, and have generally to be dealt with by men working away from large university centres and only occasionally coming into contact with pure men of science. Only those who have had to work under such conditions know what it means to attempt research work in small laboratories in the country without the stimulus of the research atmosphere, often, indeed, with the drag of a considerable amount of routine work and little opportunity of discussing the problem with the chemist or botanist who could throw much light upon it. Under present conditions almost the only opportunity the agriculturist has of meeting his fellow-workers in the region of pure science is at the British Association meeting. For this reason agriculturists are awaiting with no small interest the outcome of the proposal made last year, and carried forward another stage this year, that agricultural science shall form a definite and permanent part of the British Association programme.

In his presidential address Major Craigie dealt with the future wheat supply of the world, and showed that there was no reason for the gloomy apprehensions that have at times been raised, and particularly by Sir W. Crookes at Bristol in 1898, as to whether or not population would outstrip wheat production. The address is printed *in extenso* in NATURE (September 30).

Dr. W. Saunders gave an account of the experimental farm system in Canada. The central farm is at Ottawa, where the scientific staff reside. There are eight subsidiary stations situated at various points between the Atlantic and Pacific coasts, viz. at Prince Edward Island, Nova Scotia, Branden (Man.), Indian Head and Rosthern (Sask.), Lacombe and Lethbridge (Alta.), Agassiz (B.C.). At each of these a scheme of experiments drawn up at Ottawa is carried out under the supervision of an experienced superintendent; different varieties of crops suited to the district and different methods of management are all investigated, and the results published as widely as possible. Any abnormalities or matters of general interest that may require further elucidation are examined in greater detail at Ottawa.

The possibility of extending the food production of Canada was discussed at a joint meeting with the Economics Section, papers by Prof. Brigham, secretary of the Association of American Geographers, and Prof. Mavor, of the Toronto University, forming the text. The possible wheat area of the three provinces Manitoba, Alberta, and Saskatchewan has been put at 175 million acres, and the possible output at 3175 million bushels, which estimates are not at all accepted by the optimistic westerners. Prof. Mavor, however, points out that wheat cultivation cannot continue to be the mainstay of husbandry, but that mixed farming must become more common. Already, indeed, the wheat area is going down in Ontario, and in certain other districts it is not increasing so rapidly as the area under oats. Dry farming, which alone could be practised over large areas, is as yet on its trial. The difficulty of forming satisfactory estimates is complicated by the fact that two sets of mutually inconsistent statistics are officially issued, one compiled by the Dominion Statistical Department, the other by the provincial authorities.

A joint meeting with the botanical and chemical sections was held for the discussion of wheat problems. An important contribution to the history of the various wheats was made by Dr. Stapf, whose paper was read in his absence by Colonel Prain. Hitherto this question has been very obscure, and has formed the subject of much speculation. Dr. Stapf has succeeded in applying more precise methods, and in replacing the vague ideas hitherto held by definitely ascertained facts. The factors determining the yield of wheat formed the subject of a paper by Messrs. A. D. Hall and E. J. Russell. Wheat is very dependent on a supply of nitrogenous food-stuff; indeed, for small increments of nitrogen a more than proportional crop return is obtained. At a later stage the returns diminish, and after a time cease to yield any profit. Phosphates are of less direct importance, but have considerable indirect effect; in particular, they often enable the crop to be harvested at a somewhat earlier date, and thus they tend to extend further northwards the region of profitable production. It was also shown that wheat is capable of withstanding drought conditions, and is therefore a crop adapted to dry regions. Mr. F. T. Shutt discussed the influence of environment on the composition of the grain. Whilst not prepared to maintain that the percentage of nitrogen, phosphoric acid, or potash in the soil would appreciably affect the percentage of these substances in the grain, he nevertheless showed that the composition of the grain was influenced by its surroundings. Soil moisture affects the quantity of nitrogen present; on

adjacent pieces of ground with varying amounts of organic matter, and therefore of moisture, the nitrogen was found to decrease with increasing water content. Thus a strong wheat containing 12·5 per cent. of nitrogen yielded on newly broken prairie land a grain containing only 9·9 per cent. of nitrogen, but on adjacent older and drier land the grain contained 12·4 per cent. of nitrogen. Mr. Shutt's view is that the character of the gluten is a matter of heredity, whilst its amount depends on environment.

Two papers then followed on the strength of wheat, one, by Mr. A. E. Humphries, in which strength was described from the miller's point of view, and one by Dr. E. F. Armstrong, in which the present position of the chemistry of wheat strength was set out. Good quality is the sum of excellence in several directions. The capacity for making large, shapely, and therefore well-aërated loaves; the facility with which large masses of dough can be handled in the bakehouse; the percentage of water required to make a dough of standard consistency, are all taken into account by the miller in valuing his flour. This paper of Mr. Humphries is of great value to the chemist in that it sets forth with clearness the problem that has to be solved; correlations are now wanted between the chemical composition of the flour and these various characters. Dr. Armstrong, in a critical review which was much appreciated, showed what had been done up to the present in tracing such connections, and set forth the methods by which it is possible in particular cases to judge the value of flour. No one chemical characteristic is sufficient; account must be taken of various factors, such as the percentage of nitrogen, the size of the starch grains, and others. Prof. Harcourt then described experiments he had conducted on the baking qualities of certain flours from the western provinces. When Alberta red flour was mixed with soft Ontario winter wheat, a distinctly better result was obtained than when either flour was baked alone. The value of these flours for blending purposes was thus demonstrated. Mr. W. B. Hardy then described the experiments he had made with Prof. Wood to emphasise the importance of mineral constituents of the flour on the plasticity of the gluten.

Dr. C. Saunders approached the subject from quite a different point of view, and described his experiments in breeding wheats. It is fortunately recognised in Canada that wheat may have to be bred to suit local requirements, and indeed has to be bred if the area of the crop is to be pushed northwards. Early ripening is essential in districts where the harvest may be spoiled by frost, and early ripening varieties are being produced by Dr. Saunders at Ottawa. A note on selection was then read by Prof. L. S. Klinck, of the Macdonald College. Finally, Prof. Zavitz discussed the influence of good seed as a factor in wheat production, and described also the work done at Guelph on selection and breeding. Altogether, the wheat papers formed a valuable summary of our knowledge of the various phases of the wheat problem, and general satisfaction was felt at the decision to print them *in extenso* and to issue them in the form of a pamphlet.

Another session was devoted to the discussion of forestry problems. Prof. Somerville opened by a paper on the outlook for timber supplies, pointing out that the consumption of timber is rising faster than the supply, the growing scarcity of timber being clearly reflected in its rising prices. During the past twenty-two years, nine out of thirty-two varieties examined had risen more than 100 per cent. in price, and only two had risen less than 25 per cent. It is to the interest of every country to take energetic steps to prevent waste of timber and to plant up such lands as are not otherwise wanted. The Canadian chief forester, Mr. R. H. Campbell, followed with a paper from which it appeared that perhaps Canada is not yet fully alive to the importance of the problem. The area of forest land is probably not more than 500–600 million acres, only half of which appears to be of actual value. Suggestions were made for conserving the supply, and various administrative, educational, and legislative reforms were urged. The entomological problem was next discussed by Messrs. Lockhead and Swaine, of the Macdonald Agricultural College, who showed that much remains to be done by way of survey to ascertain the damage caused by forest insects.

A morning was devoted to live-stock problems. Mr. P. A. Mørkeberg, the Danish State expert on the breeding of dairy cattle, described the remarkable cooperative system obtaining in Denmark and its effect in increasing both the output and also the value of the output from the farms. Mr. Mørkeberg came over as the foreign representative of the subsection, and his paper was of great value by reason of its suggestiveness to the Canadian authorities, who were present, and who are faced by a not dissimilar problem. Mr. Rutherford, the veterinary inspector at Ottawa, sketched out the general character of the western cattle trade, and Prof. Somerville described his experiments at Cockle Park, in which a clay pasture has been improved by basic slag. Prof. Wilson, of Dublin, gave the results of his investigations into the history of the Aberdeen-Angus breed of cattle. The idea underlying the method is that an invading race would bring their cattle with them; thus the original cattle were black; the Romans brought white cattle; the Anglo-Saxons brought red; the Norsemen brought a hornless race; while a large flecked race was imported from Holland in the seventeenth and eighteenth centuries. Prof. Wilson examines the history of each district, and shows how the local cattle have been derived.

The last meeting of the session was devoted to soil problems. Mr. F. T. Shutt described the prairie soils as characterised by a high percentage of organic matter, intimately mingled with clay and sand. The percentage of organic matter is of the greatest importance in determining their fertility, because it so often happens that water is the factor limiting their productiveness. It is hoped that this paper, which summarises a considerable amount of work on the subject, may soon be available for the agricultural chemist. Prof. Alway followed by studies on semi-arid and arid soils, where the problem is quite different in type from that on humid soils. It was found, for instance, that a crop of clover did not increase the succeeding wheat crop, because the clover had taken too much water from the soil. A mere determination of soil moisture is not sufficient to give useful data; the hygroscopic coefficient is wanted before the result can be interpreted. Prof. King, of Wisconsin, sent an admirable summary of his work on soil moisture, which will be much appreciated by English students. The phenomena connected with the water relationships of soils were dealt with in some detail, and a very useful warning was given with regard to "dry farming." By applying certain methods of cultivation that produce a firm subsoil and a loose surface soil it is possible to economise the water supply, and therefore to raise crops in arid or semi-arid regions normally almost desert land; but Prof. King points out that the rainfall goes more or less in cycles, and that the favourable results so often quoted have in some cases, at least, been obtained in seasons when there was quite a considerable amount of rain. Whilst fully admitting the close relationship between cultivation and soil moisture, of which, indeed, his own work forms the best illustration we have, he laid stress on the fact that the large-scale methods are in no sense fully developed.

The last paper, by Messrs. A. D. Hall and E. J. Russell, dealt with the general problem of the conservation of soil fertility, especially with regard to the nitrogen of the soil. At least five factors affect the amount of nitrogen present. Two tend to increase it, viz. (*a*) bacteria fixing atmospheric nitrogen, and (*b*) the combined nitrogen brought down by the rain; and three to decrease it, viz. (*c*) drainage water, (*d*) bacterial action in decomposing organic matter, with liberation of free nitrogen, and (*e*) the growth of plants with its concomitant assimilation of nitrogen compounds. Three sets of cases were discussed. It was shown that the nitrogen content of land under arable cultivation declines when the produce is entirely removed and no organic matter is added as manure. When land rich in organic compounds is subjected to arable cultivation the destructive agents become very active, and the land loses nitrogen rapidly. On the other hand, when land is carrying natural vegetation which is not removed, there is a gain of nitrogen.

BOTANY AT THE BRITISH ASSOCIATION.

SO far as Section K is concerned, the Winnipeg meeting must be pronounced to have been a distinct success. Though less than a dozen British botanists and only one Canadian were present, the numbers attending the section were about up to the average. This was largely due to the presence of a number of American botanists, many of whom communicated papers and in other ways contributed to the success of the meeting.

The opening address of the president, Lieut.-Colonel Prain, was delivered on Thursday, August 26. It dealt chiefly with the position of modern systematic botany, and its relations to palæobotany, phytogeography, and other branches of botanical study. The address was published in full in NATURE of September 30.

The papers read during the meeting may be roughly classified according to subjects.

Cytological and Fungal Papers.

Prof. J. B. Overton (of Wisconsin) contributed a paper on the organisation and reconstruction of the nuclei in the root-tips of *Podophyllum peltatum*. After summarising the work of Grégoire and others, the author described his own observations, which, in his opinion, strongly support the view of the individuality of the chromosomes. During the passage of the chromosomes from the equatorial plate to the poles, they exhibit progressive vacuolisation. Dr. Overton believes that each individual chromosome increases in size, and ultimately forms an independent elementary reticulum. Thus the reticulum of the resting nucleus is composed of a number of these smaller reticula. Conversely, during the earlier prophases of division, the chromosomes become more condensed and distinct, and, joining end to end, give rise to the well-known spireme.

Mr. Harold Wager communicated a paper by Miss A. Peniston and himself on the nucleus of the yeast plant. The authors contend that the so-called vacuole of the yeast cell is in reality part of the nuclear apparatus. This vacuole is surrounded by a peripheral chromatin network, which in its turn is connected with a stainable nucleolus. The paper was illustrated by a number of convincing drawings.

Miss H. C. I. Fraser discussed the nuclear phenomena of Ascomycetes in relation to heredity. Fertilisation in the Ascomycetes may be either normal or degenerate. The latter, which consists of the fusion in pairs of either ascogonial or even vegetative nuclei, is found in cases where one or both sexual organs are absent. Fertilisation of either type is followed by a second nuclear fusion in the ascus. The sexual fusion is compensated by a true meiotic reduction, while the fusion in the ascus is followed by a simpler brachymeiotic division. It thus appears possible to differentiate between sexual and asexual fusion by a study of the subsequent reduction phenomena.

Prof. A. H. R. Buller (of Winnipeg) gave an account of the production and dispersion of spores in the Hymenomycetes. A number of experiments were made on the rate of spore discharge, the path of the falling spores, &c. During the paper Prof. Buller gave a pretty demonstration of the discharge of spores from the fruit-body of a species of Polyporus. By suspending the fungus in a closed glass chamber, through which a concentrated beam of light was passed, the clouds of falling spores were rendered clearly visible. A full account of this work is contained in the book on fungal researches just published by the author.

Another paper by Prof. Buller, in collaboration with Mr. C. W. Lowe, dealt with the number of bacteria in the air of Winnipeg. Observations were made on the University campus every week for a year. Both the volumetric and the plate methods were employed. During the winter half of the year the average number of micro-organisms in ten litres of air was 0·9, while in the corresponding summer half the average number rose to 10·33.

Papers on Pteridophyta.

Prof. D. H. Campbell (Leland Stanford University) read a paper on the prothallium and embryo sporophyte of Danæa, a fine series of which (belonging to several species) had been procured in Jamaica. Of the points described by the author, two may be mentioned. First, as compared with other Marattiaceæ, the ventral canal cell of the archegonium is very imperfectly developed. Secondly, no trace of a root can be found until the embryo has reached a considerable size. The first root then arises endogenously.

Prof. D. T. Gwynne-Vaughan communicated a paper by Dr. Kidston and himself on the ancestry of the Osmundaceæ. Lalesskya and Thamnopteris are two genera of primitive Osmundaceæ from the Permian deposits of Russia. The stem in these forms contains a protostele with a solid mass of xylem. The latter, however, is not homogeneous, as it consists of a central mass of short tracheids surrounded by a peripheral zone of normal scalariform tracheids. This central mass of short tracheids is held by the authors to be homologous with the parenchymatous pith of the modern Osmundaceæ. They also believe that the Osmundaceæ and Zygopterideæ have been derived from a common ancestor.

A paper was also presented by Mr. W. T. Gordon on the structure of a new Zygopteris. This species (*Z. Pettycurensis*) exhibits a protostele, a type of vascular system which had hitherto not been found in the group. This form thus occupies the same position in the Zygopterideæ as *Thamnopteris schlechtendahlii* does in the Osmundaceæ.

Ecological Papers.

Friday morning was largely devoted to the consideration of papers on ecology. The first was by Prof. H. C. Cowles, of Chicago, on the fundamental causes of succession among plant-associations. In dealing with the fact of succession, Prof. Cowles stated that plant-associations only exhibit this phenomenon when changes occur in the external conditions; but complete stability of conditions is rarely met with, so succession constitutes the normal course of events. The earlier stages may be termed the proximate, and the later ones the ultimate stages. Except in those cases where the proximate and ultimate formations are the same, as, for instance, in deserts, it is only in the ultimate stages that a plant-association becomes relatively stable. The author then discussed a number of the causes of succession. Apart from such obvious ones as topographic and climatic changes, the most important are those which are more or less associated with the plants themselves. Of these, Dr. Cowles laid especial stress on two factors: the accumulation of humus, which involves changes in the temperature, and the moisture and air content of the soil; and the increase of shade, due to the increasing luxuriance of the vegetation. The ultimate formation of any upland will be composed of plants that can germinate in the densest shade that exists there. Other factors discussed were the invasion of an area by alien species, and the influence of man. The latter makes itself felt chiefly by reason of man's destructive activity. Speaking broadly, the effect of interference by man is to keep plant-associations more xerophytic than they would otherwise be.

Prof. F. Ramaley (Colorado) discussed the Rocky Mountain flora in relation to climate. He stated that the flora of the Rockies is remarkably uniform from Canada to Colorado; but any given species must be looked for at higher and higher altitudes as one travels southwards from Canada. The author is of opinion that the chief factor which determines this altitudinal distribution is temperature. This he regards as more important in this instance than either topography, soil, or rainfall.

Prof. B. E. Livingston (Baltimore) then gave an account of the porous cup atmometer as an instrument for ecological research. The author first emphasised the importance of evaporation determinations in ecological investigations, and then described the form of instrument he has himself used. Finally, he gave some useful hints with respect to precautions to be observed when using this instrument.

Prof. R. H. Yapp gave the result of some observations and experiments on the ecology of *Spiræa Ulmaria*. This plant exhibits curious seasonal changes in respect to the formation of glabrous and hairy leaves. It was shown that the production of these two types of leaves in nature varies with the annual march of evaporation and light intensity.

Papers of Economic Interest.

On Monday, August 30, there was a joint discussion on "wheat" by the chemical, botanical, and agricultural sections. Most of the papers read at this discussion have already been noticed in NATURE (see the article on "Chemistry at the British Association," October 14, p. 475, and that on "Agriculture at the British Association" in the present number). The only one that need be further dealt with here is an important botanical contribution by Dr. O. Stapf (communicated by Lieut.-Colonel Prain), on the history of the wheats.

The wheats are generally divided into (*a*) the wheats proper, with tough spindles to the spikes, loose grains, and thick pericarps (N.B.—the first two of these characters are of economic importance, as they greatly facilitate threshing); (*b*) the spelt wheats, with brittle spindles, grains tightly enclosed in the husks, and thin pericarps. The former comprise the soft, hard, and English wheats, together with the dwarf and Polish wheats. The latter include the spelt wheats proper, the emmer and the einkorn wheats, and also the wild *Triticum aegilopioides* and *T. dicoccoides*.

After careful investigation, and in the light of recent discoveries, Dr. Stapf concludes that all the varieties of modern wheat may be traced to some four distinct primitive wild types:—(1) the einkorn to *Triticum aegilopioides*, with its original home in Asia Minor and the Balkans; (2) the emmer and the hard wheats, as also the English and Polish, to *Triticum dicoccoides*, recently re-discovered by Mr. Aaronsohn in northern Palestine; (3) the spelt proper to *Triticum cylindricum*, in an area extending from Rumania to southern Russia; (4) the common or soft, and probably also the dwarf, wheats, to a still unknown species, which probably occurred either in Syria or Mesopotamia.

Dr. Stapf concluded his paper with an appeal for the systematic collection of all the wheats at present cultivated in the Old World, which must, he said, still include many of the more primitive races; also for a further exploration of the Orient, which might well result in the discovery of new wild forms.

Other papers of agricultural interest were read by Prof. H. Bolley (North Dakota), on the destruction of weeds in field crops by means of chemical sprays; and by Prof. Pammel (Iowa), on the delayed germination of seeds. The latter author experimented with the seeds of a number of species of weeds. He found that if the seeds were kept during the winter in paper packages, the percentage germination was lower, and the dormant period longer, than if the seeds were placed in sand and exposed to the climatic conditions of an ordinary winter.

On Thursday afternoon Mr. J. Parkin gave an interesting account of the industry of rubber cultivation. He referred to the various rubber-yielding trees, and more particularly to *Hevea braziliensis*, the Para rubber tree. After describing the introduction of the latter into the eastern tropics, Mr. Parkin dealt with the methods employed in tapping the rubber trees. He fully discussed the relation between the yield of rubber and the phenomenon known as "wound response," and also the nature of latex coagulation. The paper was fully illustrated with specimens of the plants, commercial rubber, the instruments used, &c. Mr. Parkin also demonstrated the actual coagulation of rubber latex.

Other Papers.

In contrast to the Dublin meeting, there was a noticeable dearth of physiological papers. One, however, was contributed by Prof. R. Willstätter, on the chemistry of chlorophyll. One of the points emphasised by this author was the essential difference between chlorophyll and hæmoglobin in respect to the metals bound up in their respective molecules. Iron occurs in that of hæmoglobin, while in the case of chlorophyll the iron is replaced by magnesium. The action of acids and alkalis on chlorophyll was also discussed.

Mr. J. Parkin put forward some rather novel views as to the evolution of the inflorescence. He is of opinion that racemose inflorescences have been in all cases derived from cymose. According to his view, solitary terminal flowers were primitive; these were succeeded by simple dichasia, and these by compound dichasia. From the latter, racemose inflorescences may have been derived by an increase in the number of lateral flowers, with suppression of tertiary branching, and, finally, of the original terminal flower itself.

Miss E. J. Welsford described the life-history of *Trichodiscus elegans*, an alga belonging to the Chætophoraceæ. It was found in this species that various forms of reproduction may occur under identical external conditions. These results are somewhat at variance with the well-known experiments of Klebs.

Dr. R. R. Gates (Chicago) discussed the effects of tropical conditions on the development of certain English Œnotheras. Two species were grown from seed in a tropical greenhouse. The resulting plants were usually found to continue indefinitely in the rosette stage. Even when ordinary stems were produced they exhibited marked fasciation.

The Semi-popular Lecture.

This was given on the Friday afternoon by Mr. Harold Wager. He chose for his subject the perception of light in plants. The lecturer dealt with the problem as it affects both the lower, free-swimming organisms, such as Euglena, Chlamydomonas, &c., and also the various orthotropic and diatropic organs of the higher plants. With respect to the latter, Mr. Wager criticised Haberlandt's view of the ocellar function of the epidermal cells of leaves. While agreeing that the optical behaviour of those cells may in general be as Haberlandt suggests, the lecturer inclined to the view that the chlorophyll grains, rather than the cytoplasmic lining of the epidermal cells, constitute the actual percipient organs. The lecture, which was thoroughly appreciated, was well illustrated by a number of beautiful photographs.

Several botanical excursions were arranged during the meeting by the local secretary, Prof. Buller. One of these was to Hedingly, where a fine bit of uncultivated prairie was examined. Another was to Winnipeg Beach, on the shores of Lake Winnipeg. On a third occasion Elm Park, on the Red River, was visited. Some of the members of Section K also took part in the western excursion, and so had a further opportunity of witnessing some of the remarkable types of vegetation to be found in travelling from east to west across the North American continent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—It is proposed that, in accordance with the recommendation contained in a report of the council of the Senate on the endowment of a professorship of German, the generous offer of Messrs. J. Henry Schröder and Company of the sum of 20,000*l.* for the endowment in the University of a professorship of German, to be known as the Schröder professorship of German, be gratefully accepted, and that the thanks of the University be conveyed to the donors.

The superintendent of the museum of zoology has appointed Mr. C. L. Boulenger to the office of assistant to the superintendent of the museum of zoology for one year from October 1, 1909. Mr. H. H. Thomas has been appointed curator of the botanical museum for a period of three years from Michaelmas, 1909, and Mr. Gordon Merriman has been appointed to the studentship in medical entomology lately held by Mr. F. P. Jepson.

The Vice-Chancellor, Mr. R. F. Scott, Mr. Fitzpatrick, Prof. Kenny, Dr. Anderson, Prof. Sorley, Sir J. J. Thomson, Mr. R. T. Wright, Mr. C. E. Grant, and Mr. H. McL. Innes have been nominated a syndicate to consider the question of providing pensions for professors and others in the service of the University.

LONDON.—At the meeting of the Senate held on October 20, the degree of D.Sc. was granted to Mr. L. L. Fermor, an external student, for a thesis entitled "The Manganese Ore Deposits of India," and other contributions; and to Mr. S. Russ, an internal student, of University College, for a thesis on "The Active Deposits of Radio-active Substances."

MANY old students of the Royal College of Science and Royal School of Mines having expressed the opinion that there should be a reunion in the Midlands, in addition to the annual dinner of the Old Students' Association in London, arrangements have been made for a dinner at the Imperial Hotel, Birmingham, on Saturday, November 6. Tickets or particulars can be obtained from Mr. Philip C. Coultas, Municipal Technical School, Birmingham.

THE commissioners under the Irish Universities Act, 1908, have appointed the following professors, among others, in University College, Dublin :—mathematics, H. C. M'Weeney; chemistry, Dr. Hugh Ryan; experimental physics, Dr. J. A. M'Clelland; mathematical physics, Dr. Arthur W. Conway; zoology, Dr. George Sigerson; anatomy, Dr. E. P. M'Loughlin; surgery, J. S. M'Ardle; geology, H. J. Seymour; physiology and histology, Dr. B. J. Collingwood; pathology and bacteriology, Dr. E. J. M'Weeney; medicine, Sir Christopher Nixon; civil engineering, P. F. Purcell.

THE following candidates were successful in this year's competition for the Whitworth scholarships and exhibitions :—*Scholarships* (tenable for three years), 125*l.* a year each. A. W. Judge, Plymouth; J. Airey, Shipley; H. S. Rowell, Newcastle-on-Tyne; H. Mawson, Leeds. *Exhibitions* (tenable for one year), 50*l.* each. F. Duncanson, Sunderland; A. Ryan, Oldham; A. H. Campbell, Portsmouth; J. J. Clark, Liverpool; W. H. Shinkfield, Portsmouth; A. W. Stevenson, Melrose; G. W. E. Hayward, Southsea; J. Morgan, Sheerness; A. F. Grieveson, Chatham; A. E. Gladwyn, Plumstead; W. H. T. Harvey, Swindon; T. H. Webster, Newcastle-on-Tyne; W. J. Davis, Plymouth; O. R. Randall, Birmingham; G. F. Haddock, Sunderland; F. H. Reid, Plymouth; G. B. Kellagher, Gillingham (Kent); T. Norcross, Hollinwood, Oldham; L. P. Parker, Leytonstone; A. Morris, Portsmouth; J. Smith, Crewe; W. Shaw, Woolwich; H. E. Pinch, Sheerness; D. H. Emby, Plumstead; W. Fox, Plumstead; R. H. May, Leytonstone; E. D. Brodie, Swindon; H. J. Goudie, Leith; H. Collins, Gillingham (Kent); C. Williams, Plumstead.

ON October 20 the University of Birmingham held the first special degree congregation since its inauguration. In commemoration of the Royal opening of the University in July last, a number of distinguished persons received honorary degrees. Among the representatives of pure and applied science upon whom was conferred the honorary degree of Doctor of Laws were Mr. W. N. Atkinson, H.M. Inspector of Mines for South Wales; Mr. H. T. Butlin, president of the College of Surgeons of England; Sir William Crookes, F.R.S.; Mr. Maurice Fitzmaurice, C.M.G., engineer-in-chief to the London County Council; Sir Archibald Geikie, K.C.B., president of the Royal Society; Dr. John S. Haldane, F.R.S., reader in physiology to the University of Oxford; Sir Alexander Kennedy, F.R.S.; Sir Joseph Larmor, Sec.R.S., Lucasian professor of mathematics in the University of Cambridge; Sir Richard D. Powell, K.C.V.O., president of the Royal College of Physicians; Sir William Ramsay, K.C.B., F.R.S.; Lord Rayleigh, O.M., F.R.S.; Prof. E. Rutherford, F.R.S., professor of physics in the University of Manchester; Prof. S. P. Thompson, F.R.S.; Prof. W. A. Tilden, F.R.S.; Sir Joseph Thomson, F.R.S.; Mr. C. S. Tomes, F.R.S., past-president of the Odontological Society of Great Britain; and Dr. B. C. A. Windle, F.R.S., president of University College, Cork.

THE issue of *Science* for October 15 announces the following gifts to higher education in the United States. Yale University has received from Mr. W. D. Sloane and Mr. H. T. Sloane the sum of 95,000*l.* to build, equip, and endow a physical laboratory. This laboratory, it is understood, will replace the present Sloane Physical Laboratory. Yale University has also received 5000*l.* from Mr. A. G. Vanderbilt for general endowment, and 3000*l.* from Mr. G. H. Meyers for the endowment of the Forest School. Columbia University has received gifts amounting to about 47,200*l.*, of which 22,500*l.* is from Mr. W. H. Charpentier, to be added to the J. S. Charpentier fund, and 20,000*l.* is given anonymously. The Pratt Institute of Brooklyn has received the sum of 350,000*l.* from Mr. Charles M. Pratt, son of the founder and now its president, and from his five brothers and his sister, Mrs. E. B. Dane. Dr. D. K. Pearsons has offered to give 20,000*l.* to Berea College, provided that the sum of 80,000*l.* is otherwise subscribed, and Mr. N. B. Duke has made a further gift of 10,000*l.* to Trinity College at Durham, N.C.

THE first part of "Statistics of Public Education in England and Wales," 1907–8, has been published (Cd. 4885) by the Board of Education, and deals wholly with educational statistics. We notice that during the year thirty-five technical institutions were recognised by the Board, these being defined as institutions giving an organised course of instruction in day classes, including advanced instruction in science, or in science and in art, and provided with a staff and equipment adequate for the purpose. Provision must be made in such institutions for at least a two years' systematic course in science, or in science and art, either alone or in conjunction with subjects of general commercial, manual, or technological instruction. With a few exceptions, no student may be admitted to the course unless he has passed through a three years' course in a recognised secondary school, or is more than sixteen years of age and is qualified from his general education to profit by a course of advanced instruction. There were in these thirty-five institutions 644 teachers, while 2768 students attended at some time during the year, though 1630 only attended a full course of instruction. It is noteworthy that twenty-one of the teachers were women, and 198 of the students were girls or women. Of the 2570 boys and men in attendance, 7 were fourteen years of age; 492 were fifteen and under seventeen years of age; 465, seventeen and under eighteen years of age; 439, eighteen and under nineteen; 343, nineteen and under twenty; 232 were twenty and under twenty-one; and 592 were twenty-one years of age or more. It must be remembered that, in addition to these students, there were many others attending day technical classes. The Board recognised day technical classes in ninety-six institutions during the year, and upwards of 9000 students attended these classes at some time or other during the year.

SOCIETIES AND ACADEMIES.

LONDON.

Institution of Mining and Metallurgy, October 21 — Mr. Edgar Taylor, president, in the chair.—The influence of the railroads of the United States and Canada on the mineral industry: Dr. J. **Douglas.** After a brief historical summary of the development of the railroad systems of the North American continent, the author gave statistics of the mileage and traffic of the various railroads, showing the proportion of mineral traffic conveyed and its nature. He also showed the part taken by improved railroad communication in developing the mineral resources of the continent, and sought to prove that as the vast regions so far untouched by railroads, especially in Canada, are opened up, it is reasonable to conclude that greater stores of mineral wealth will be discovered and developed.—The development of heavy gravitation stamps: W. A. **Caldecott.** The author opened his subject with the statement that the history of ore crushing by means of gravitation stamps shows a progressive increase in their weight and in corresponding efficiency, and by means of figures he proceeded to prove how closely the factors of weight and efficiency are related. The first stamp-mill erected in the United States, in 1835, was equipped with 50 lb. stamps, this weight being increased to 380 lb. ten years later. Nowadays, on the Rand and elsewhere, stamps are in operation weighing as much as 1750 lb. In the meantime, however, the introduction of secondary grinding by means of tube mills, &c., has modified the original requirements of a stamp-battery, and tended to render the heavier stamps more efficient for their present purpose than were the older and lighter stamps under then existing conditions. The author concludes that the future limit of weight is difficult to foretell, and may be determined by mechanical considerations rather than by any decrease of relative efficiency as a device for pulverising ore. The data given as the result of exhaustive experiments with different weights and duties of stamps add considerably to the practical value of the paper.

MANCHESTER.

Institute of Metals, October 14.—Sir William White, K.C.B., F.R.S., president, in the chair.—The constitution and properties of the ternary alloys aluminium-copper-tin: J. H. **Andrew** and C. A. **Edwards.** The authors recorded an interesting series of conclusions of both a practical and theoretical character, based on a prolonged research which had necessitated the preparation and testing of many hundreds of alloys.—The surface appearance of solders: C. O. **Bannister** and H. J. **Tabor.** Results were given of experiments carried out with a view to obtain exact information as to the effect of small quantities of impurities on the surface appearance of solders, the impurities added to ordinary tinman's solder (50 per cent. tin and 50 per cent. lead) being antimony, copper, silver, and zinc.—Some causes of the corrosion of copper and brass: E. L. **Rhead.** The author dealt particularly with the corrosion of condenser tubes. Samples of hard copper and brass were submitted to corrosion in various saline solutions, some of which were saturated with CO_2. Strips of hard brass were softened at one end and bent into U-shape. It was found that there was a much greater tendency for the hard material to corrode, the corrosion occurring in lines parallel to the direction of rolling. The surface of the hard metal was made very rough and irregular, whilst that of the soft metal remained quite smooth, when both were immersed in saline solutions.

October 15.—Sir William White, K.C.B., F.R.S., president, in the chair.—The copper-zinc alloys: a study of volume changes during solidification: Prof. T. **Turner** and M. T. **Murray.** The authors held that their experiments were likely to have an important theoretical as well as practical bearing, and it was believed that expansometer tests would be largely used in future as an aid to the determination of the constitution of alloys.—The elastic breakdown of non-ferrous metals: Prof. C. A. **Smith.** The author gave the result of researches conducted by means of his instrument, the sphingometer, which showed that, so far as the elastic properties of the material were concerned, mild steel was very much more trustworthy than any non-ferrous metal. The sphingometer was described, and shown to be capable of measuring extensions of length of the astonishingly small amount of a quarter of a millionth part of an inch.—Notes of the production of pure spelter: J. S. **Primrose.** A review of the commercial position of zinc and the existing methods of refining the metal, the author also discussing the theory of the new process of fume filtration purification during distillation.—The technical assay of zinc: H. W. **Greenwood** and Dr. E. J. **Bristoe.** The paper described work undertaken with a view to determine the relative value and accuracy of the various analytical methods for the determination of zinc, and also the gathering together of the more important references to the analytical chemistry of zinc in both British and foreign literature. The authors reviewed briefly the more important processes, volumetric, gravimetric, and electrolytic, for the estimation of zinc.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 28.

SOCIETY OF DYERS AND COLOURISTS, at 8.—Some Unsolved Dyeing Problems: Dr. E. Feilmann.

FRIDAY, OCTOBER 29.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Prof. W. E. Dalby's Report on Heat Transmission (*Resumed Discussion*).

MONDAY, NOVEMBER 1.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Technical Gas Calorimetry: J. H. Coste.—On Naphthalene Picrate and the Quantitative Determination of Naphthalene: W. P. Jorissen and J. Rutten.—Some Notes upon the Manufacture of Large Blocks of Artificial Stone from Sand and Lime: J. C. Stead.

ARISTOTELIAN SOCIETY, at 8.—Presidential Address: Sensations and Images: Dr. S. Alexander.

TUESDAY, NOVEMBER 2.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by the President, J. C. Inglis.

WEDNESDAY, NOVEMBER 3.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Note on the Detection and Estimation of Small Quantities of Antimony: Dr. P. Schidrowitz and H. A. Goldsbrough.—The Phosphates in Certain Vinegars, and in the Materials used in their Manufacture: T. Fairley.—On the Determination of Essential Oils in Spices and Aromatic Drugs: R. A. Cripps and J. A. Brown.—Note on Holde's Test, and the Detection of Paraffin Wax in Lard and other Fats: H. Dunlop.

GEOLOGICAL SOCIETY, at 8.—(1) Certain Jurassic (Lias Oolite) Strata of South Dorset, and their Correlation; (2) Certain Jurassic (Inferior Oolite) Species of Ammonites and Brachiopoda: S. S Buckman.—(1) The Cretaceous and Eocene Strata of Egypt; (2) The Granite Ridges of Kharga Oasis: Intrusive or Tectonic? Dr. W. F. Hume.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: (1) The Development of *Trypanosoma Gambiense* in *Glossina palpalis*; (2) A Note on the Occurrence of a Trypanosome in the African Elephant: Colonel Sir David Bruce, C.B., F.R.S., Captains A. E. Hamerton and H. R. Bateman, R.A.M.C., and Captain F. P. Mackie, I.M.S.—On the Perception of the Direction of Sound: The Lord Rayleigh, O.M., F.R.S.—The Diffraction of Electric Waves: Prof. H. M. Macdonald, F.R.S.—On the Mechanism of the Absorption Spectra of Salutions: Robert Houstoun.—(1) Note on the Spontaneous Luminosity of a Uranium Mineral. (2) The Accumulation of Helium in Geological Time: Hon R. J. Strutt, F.R.S.—On the Physical Properties of Gold Leaf at High Temperatures: J. C. Chapman and H. L. Porter.—The Dimensions and Function of the Martian Canals: Dr. H. C. Pocklington, F.R.S.

LINNEAN SOCIETY, at 8.—Some Account of the Field-botany of Namaqualand, Damaraland, and South Angola: Prof. H. H. W. Pearson.

RÖNTGEN SOCIETY, at 8.15.—Presidential Address: C. E. S. Phillips.

FRIDAY, NOVEMBER 5.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Huxley Memorial Lecture. The North European Race: Prof. G. Retzius.

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