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

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AND BUNGAY, SUFFOLK.

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EARLY NATURALISTS.

The Early Naturalists. Their Lives and Work (1530–1789). By Dr. L. C. Miall, F.R.S. Pp. xi+396. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* net.

IN this account of the naturalists who worked and wrote during the period between the commencement of the Protestant Reformation and that of the French Revolution, Prof. Miall has placed under a considerable obligation those who are interested in the advancement of natural knowledge. The period to which the work is in the main limited constitutes perhaps as natural an epoch as may be found in human history. Whether the period be natural or not, the charming introductory sketch of "Natural History down to the Sixteenth Century" fully justifies the selection of the date at which the author's account of scientific progress formally opens, while the closing date adopted is at least convenient. But the work is one that could only have been written with unusually full knowledge of the scientific happenings since the date of Buffon's death, and it is owing to the possession of this knowledge that the author has been able to assess so authoritatively as he does the extent and the value of the permanent additions to biological truth which marked the period he passes under review.

The work, in the main, deals, as its title implies, with the lives and the labours of the naturalists who flourished during the period in question. In his treatment of the subject Professor Miall strikes a happy mean between the methods of the skilled biographer and of the formal historian of human progress. As a result, he succeeds in enabling the reader to acquire a clear conception not only of what was accomplished during the period, but of the character of those by whom the work was done and of the intellectual atmosphere in which they lived. To the personal interest thus aroused is largely due the force of the incisive estimates provided by the author of men like Clusius and Belon, Ray and Leeuwenhoek, Réaumur and Buffon, to mention only a few of the worthies whose lives are discussed. Even in those rare instances in which the reader may feel inclined to differ from Prof. Miall, it will be admitted that his estimates are the result of complete knowledge and judicial thought; any disinclination to accept the verdicts depends not on the facts, but on the point of view from which these facts are regarded.

There is, however, a certain want of unity in the work. In addition to the accounts of individual naturalists which we conclude from the title to be its main subject, the book contains a series of essays of a different type, each of them as self-contained as the character-sketches of which the work is principally composed. One of these, already alluded to, aptly serves as an introduction to these sketches. Another, on "The Natural History of Distant Lands," is interpolated between the accounts of the earlier Continental and the earlier English naturalists, but scarcely serves as a connecting link between the one group and the other. This essay is, however, so interesting in itself that one welcomes it as a digression, which at least does not carry us beyond the later limit of the period discussed, and may be excused for taking us back further than its earlier one.

Two similar essays, equally self-contained, on "The Investigation of the Puss Moth," and on "Early Studies of the Flower," which are not accorded the position of distinct sections, but are incorporated in other sections, deviate more considerably from the plan of the work as a whole; the former brings us down to the present day, while the latter carries us from Theophrastus to the first De Candolle. Still, both essays are germane to the purpose of the book, and add so much to its value that it would be more than ungracious to cavil at their presence among these delightful and informing sketches of the "Early Naturalists."

THE WANDERING OF THE BRONZE AGE POTTERS.

A Study of the Bronze Age Pottery of Great Britain and Ireland, and its associated Grave-goods. By the Hon. John Abercromby. Vol. i., pp. 163+lxi plates. Vol. ii., pp. 128+plates lxii–cx. (Oxford: Clarendon Press, 1912.) Two volumes, price £3 3s. net.

ARCHÆOLOGISTS have long been looking forward to the Hon. Dr. John Abercromby's monograph on Bronze Age pottery, and, as was to be expected, it has proved to be exhaustive and workmanlike. As an indication of the pains which the author has taken, it may be mentioned that there are photographs of 54 Continental beakers, 291 British beakers, 421 food vessels, 570 cinerary urns, numerous photographs of other objects, several plates of details of ornamentation, and a number of valuable maps of distributions. A classified list of the vessels illustrated in the plates would save the reader a great deal of trouble. The purely descriptive matter is as succinct as possible, though all essential information is given, and as there are full references the student knows where to go for further details.

Not only have we data of form, ornamentation, and distribution, but Dr. Abercromby has sought to make them tell a tale by coordinating other finds, such as skulls, implements, beads, &c. He rightly endeavours to give a picture of the life of the people, but some of his speculations on their social condition and religious beliefs are too hypothetical, and are scarcely consistent with the scientific method he adopts when dealing with his immediate subject. His general conclusions may be summarised as follows. About 2000 B.C. it would seem that Britain was invaded by a rugged, enterprising people, mainly of Alpine stock, whose ancestors, perhaps three to four hundred years earlier, had lived beyond the Rhine, not very far north of Helvetia. They had scarcely emerged from the neolithic stage of culture, and perhaps brought no single copper or bronze knife among them, but not long afterwards they possessed such small implements, and perhaps flat axes. Their wealth must have consisted in cattle, sheep, goats, and swine. They were also acquainted with cereals. They were not an inventive people, for they had only two forms of sepulchral pottery, which lasted with small variations for about 500 years, and they never abandoned geometrical ornamentation. Women were buried with as much ceremony as men. They presumably spoke an Aryan language.

The invaders probably landed on the coast of Kent, and in course of time some moved north and others west; these began to cluster on the Wiltshire downs, especially round what is now Stonehenge. About 1880 B.C. the northern branch crossed the Humber into East Riding, where they also found the earlier natives in possession. About this time their influence had reached Hibernia, in the shape of a beaker, though they themselves may not have crossed over so early. Not until about 1600 did they colonise the south coast of Moray Firth, and the extreme north was reached some time later. By 1500 B.C. the direct evidence of the brachycephalic invaders ceases. In the south their ceramic ended, and the skull-type was obliterated by cremation; but they were not exterminated. It is not unlikely that Stonehenge was erected about 300 years after the invasion.

About 1350–1150 there was a remarkable development of material civilisation in south Britain, new forms of small, often beautifully made cups are first met with, and there were skilful artificers in gold; traces of foreign influences are also met with. From about 1150 to 900 B.C. is an obscure period, with diminished material wealth. During the next period (*circa* 900–650), south Britain was entered by new tribes, apparently refugees, who introduced a new form of entrenchment and new forms of pottery, some of which have analogies east of the Rhine, others about the northern base of the Pyrenees. There is no evidence that they spread north of the Thames. During the period beginning *circa* 900, the population increased, and the dead were interred in flat cemeteries, though barrows never fell entirely into disuse; the change was not due to foreign influence, as the contemporary pottery from cemeteries and barrows is identical. The period from 650–400 is obscure; in remote parts like Dorset and Ross-shire, the Bronze Age certainly lasted till about 200 B.C.

This admirable monograph breaks new ground, and will long remain the standard work on the early Bronze Age of the British Islands.

A. C. HADDON.

OUR BOOKSHELF.

The Inter-Relationships of the Bryophyta. By Dr. Frank Cavers. Reprinted from the *New Phytologist.* Pp. vi+203. Cambridge: At the Botany School, 1911. Price 4s.; postage 4d.

WE are a little late in announcing that Dr. F. Cavers's series of articles which appeared on the inter-relationships of the Bryophyta in the *New Phytologist,* vols. ix. and x., 1910–11, has been issued separately. It is a great convenience to have the work in this form, and it certainly deserves this distinction. The classification is mainly that adopted in Engler and Prantl's "Natürlichen Pflanzenfamilien," but as a result of his investigations the author introduces some modifications. His proposed divisions are: (1) Sphærocarpales, (2) Marchantiales, (3) Jungermanniales, (4) Anthocerotales, (5) Sphagnales, (6) Andreæales, (7) Tetraphidales, (8) Polytrichales, (9) Buxbaumiales, and (10) Eu-Bryales.

Dr. Cavers discusses more particularly the question of the old primary division of the Bryophyta into two classes, Hepaticæ and Musci, especially in relation to the Anthocerotales and the Sphagnales. He argues: "If the Anthocerotales are to be made a separate class apart from the Hepaticæ, either Sphagnales should also be considered a separate class apart from the Musci, thus making four primary divisions of Bryophyta —Hepaticæ proper, Anthocerotes, Sphagna, and Musci proper—or the Anthocerotales and Sphagnales might be united to form a class between the Eu-Hepaticæ and the Eu-Musci, thus giving three classes of Bryophyta." But he prefers dividing the Bryophyta into ten groups as designated above.

The account of *Riella capensis* is of special interest, and it is to be followed by a more detailed paper on the genus generally. Until 1902 this singular aquatic genus was only known to inhabit the Mediterranean region and the Lake of Geneva. Since then a species has been discovered in the Grand Canary; another in Texas; a third in Turkestan; and a fourth in South Africa.

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.*]

Determination of the Epicentre of an Earthquake.

IT has been proved by observation with the Galitzin seismographs, both at Pulkowa and Eskdalemuir, that when the first phase P of an earthquake is sharp, the azimuth of the epicentre from the station is uniquely determined by the observations at that station. It follows that if the azimuth of the epicentre is determined at two independent stations suitably situated, the epicentre can be determined from these two azimuths alone.

We have to-day, as an example, verified by construction and by computation that this principle gives accurately the epicentre of the earthquake that occurred in Monastir on February 18, 1911.

The azimuth observed at Pulkowa was 22° 53′ west of south, while the azimuth observed at Eskdalemuir was 55° 56′ east of south. The resulting epicentre we find to be 40·5° N., 20·3° E.

The epicentre deduced by the Pulkowa observations of azimuth and epicentral distance was 40·5° N., 20·1° E.; while the similar deduction from the Eskdalemuir results was 40·3° N., 20·4° E.

It is clear that in this case the accuracy of determination from the azimuths alone equals that of the determinations from the separate stations, and it is known that the earthquake did occur in the region indicated.

The advantages of this new method based on azimuths alone are:—

(1) That it is quite independent of any time reckoning whatever at the two stations.

(2) That it is independent of the determination of the second phase S on a seismogram (which is frequently difficult to fix with certainty).

(3) That it is independent of any empirical tables for epicentral distance, which are admittedly only approximate.

(4) Although only two stations are used, the determination is unique.

We may observe that for a given case the accuracy of determination depends on a suitable choice of the two stations.

B. GALITZIN.
GEORGE W. WALKER.

The Observatory, Eskdalemuir, Langholm, Dumfriesshire, August 29.

Implements of Man in the Chalky Boulder Clay.

IN NATURE of August 15 Mr. Reid Moir has given us certain interesting facts observed by him in connection with the scratching of flints.

(1) He notes the occasional scratching of what remains of the "cortex" of the original nodule. It does not seem to have occurred to him that such a result may have been produced while the flint was still enclosed in its original chalk matrix. Topley (in his "Geology of the Weald") showed long ago that the chalk strata had in many cases undergone considerable differential movement concomitant with crustal movements; and I have myself seen crushed flints still *in situ* in the chalk cliffs at Ventnor, where there is evidence of intense crustal movement of the strata. So far back as 1880 I noted this, also the extremely fractured and unworn condition of the flints left as a residuum from the solution of the chalk by carbonated rain-water on the top of St. Boniface Downs (see P.G.A., vol. viii., No. 3), and my interpretation of the phenomena there observable has since been confirmed by Dr. A. Strahan, F.R.S., of the Geological Survey. Here we have a sufficient mechanical cause totally independent of anything that may be connoted by the term "glaciation." There seemed, moreover, to be just that slight amount of surface-staining of the fractured surfaces which might be due to meteoric iron-dust.

(2) One fails to see that there is any mystery about the non-striated condition generally of the fracture-surfaces of the flint fragments from the Boulder Clay. How could the soft matrix of the Boulder Clay scratch a flint, or even hold a harder stone with sufficient grip to give it effect as a graving-tool, however great the volume-pressure may have been? When the "glazier" wants to cut glass he does not use putty to hold his "diamond." So much for the talk of "intense glaciation" of hypothetical pre-Crag flints, on which I hope to have shortly more to say.

On the other hand, boulders of the Chalk itself, if at all rounded by the shearing movement of the ice in which they were once embedded, are often scratched and grooved. (See further my paper on the mechanics of glaciers, Q.J.G.S., February, 1883; also NATURE, June 20, 1912.)

I can assure Mr. Reid Moir that the delicate and interesting subject of *patination* presents difficulties to those who (in microscopic and laboratory work) have brought some knowledge of physics and chemistry to bear on the *lithology of the flint*, and that it is not to be dismissed in the easy way he seems to suppose. Nor do I think that even Dr. Sturge (Proc. Prehis. Soc. of E. Anglia) has adequately dealt with the subject or with the possible causes of some phases of "striation." A. IRVING.

Bishop's Stortford, August 22.

THE FIFTH INTERNATIONAL CONGRESS OF MATHEMATICIANS AT CAMBRIDGE.

THE first Mathematical Congress was held at Zurich in 1897, the second at Paris in 1900, the third at Heidelberg in 1904, and the fourth at Rome in 1908. This year's congress met at Cambridge, August 21–28, under the presidency of Sir G. H. Darwin, and was divided into sections as follows:—I, Analysis; II, Geometry; III (*a*), Physical Mathematics; III (*b*), Statistics; IV (*a*), Philosophy and History; IV (*b*), Didactics. Several meetings of the last section were held in connection with the International Commission on the Teaching of Mathematics, which was formed by a resolution of the fourth congress to study and report on the actual state of mathematical teaching in various countries.

Receptions were given by the Chancellor, Lord Rayleigh, in the Fitzwilliam Museum, by Sir G. H. Darwin in St. John's and Christ's Colleges, and by the Master and Fellows of Trinity College. Visits were made to the University observatory and to the works of the Cambridge Scientific Instrument Company. Excursions were arranged to Ely Cathedral, Oxford and Hatfield House. Throughout the week the University and colleges displayed their customary hospitality to the full, and the appreciation of the visitors, both English and foreign, was very evident. The members numbered 572, as compared with 535 at the fourth congress, and included representatives from Brazil, Chile, Egypt, India, Japan, and Mexico. An exhibition organised by the Mathematical Association was arranged in the Cavendish Laboratory, and included English and foreign text-books, examples of school work, models and apparatus, and a most interesting and complete collection of calculating machines. Eight lectures were delivered to the whole congress, and we mention below a few of the less technical points occurring in these, and in the meetings of the didactic section.

Sir G. H. Darwin (Cambridge), in welcoming the congress at the first meeting, referred to the death of Henri Poincaré, whom he described as the one man who alone of all mathematicians might have occupied the position of president of the congress without misgivings as to his fitness. It brought vividly home to him how great a man Poincaré was, when he reflected that, to one incompetent to appreciate fully one half of his work, he yet appeared as a star of the first magnitude.

Prof. E. W. Brown (Yale) lectured on "Periodicity in the Solar System." Newton and his contemporaries aimed at obtaining functions which should express the positions of individual bodies at all epochs. This is now recognised as unattainable; and the position within certain limits of time is expressed by infinite series of terms, some of which are harmonic representing periodic motions, and others expressed as powers of the time representing secular motions. These series are carried to a degree of accuracy exceeding that of the most delicate observation; so that where the calculated positions differ from those observed by a quantity exceeding the possible error of observation, it may be safely assumed that forces are in action other than those postulated in the theory. This is notably the case in the theory of the moon, where the outstanding discrepancy is comparable with the largest of the perturbations due to the planets. Dynamical theory in the case of the asteroids has shown that in the particular case of the problem of four bodies when the mass of one is small, the motion of the latter is unstable for certain ranges of value of the radius vector; and no asteroids have, in fact, been found within these limits. It is possible that an explanation may here be foreshadowed of the dark intervals in Saturn's rings.

Prince B. Galitzin (St. Petersburg) lectured on "The Principles of Instrumental Seismology." The usual seismographic record shows three chief groups of disturbances, due respectively to the longitudinal and transverse waves through the core of the earth, and to the superficial wave round the crust. These, however, are complicated and supplemented by reflections of the deep waves at the surface, and sometimes also by twin earthquakes caused by the primary. The relations between the elastic constants of the core deduced from seismographic observations are in fair agreement with the theory of elasticity of an isotropic medium. But an attempt has been made to construct a more general theory assuming heterogeneity depending on depth. The ideal aim of seismometry must be the determination of the six components of motion of a particle of the earth's crust throughout the whole of a disturbance. Hitherto attention has been confined to the three components of translation. The practical problem of recording the three components of rotation seems to have been solved recently in an apparatus in which induced currents from two pendulums are passed simultaneously in opposite directions through the same galvanometer. There is even reason to believe that the problem of predicting earthquakes is not so hopeless as it would *a priori* seem to be.

Sir W. H. White lectured on "The Place of Mathematics in Engineering Practice." It is matter for surprise that many of the great engineering discoveries of the last century were made by men who had little or no mathematical or scientific training. On the other hand, much good work was done by French mathematicians in the eighteenth century in laying the foundations of naval architecture. The discussions of recent years have tended to the conclusion that the mathematical portion of an engineer's training is best given in the regular manner by a mathematician, rather than in a selected course by an engineer. There can be no doubt as to the value of mathematics, both in indicating the lines along which experiments must be made and in framing a theory from their results. Many problems, such as that of the design of ship propellers, stand urgently in need of the mathematician's help.

At an extra meeting of Section IV, Mr. P. J. Harding lectured on "The History and Evolution of Arithmetic Division." The two methods of calculation prevalent in Europe previous to the introduction of the Arabic numerals were that of the algorists, who used counting-boards ruled with lines representing successive powers of ten on which counters were placed, and that of the abacus. Arabic numerals followed the trend of commerce from India through Arabia and Italy into northern Europe; so far as we know, they first appeared in Italy in 1202. Subtraction was first performed from the left by scratching out the digits successively, a method evolved from the sand-board used in the East, which was small compared with the size of the numerals, so that successive deletion was necessary. From this followed the method of division by scratching, known as the galleon method owing to a fancied resemblance of the resulting disposition of digits to the form of a ship. The modern method of division first appeared in print in Italy in 1494, but it only superseded the galleon method after a struggle which lasted more than a century. In England its ultimate triumph was largely due to the writing-master Cocker, who advocated it to the exclusion of the older method.

At a special meeting of Section III (*a*), Sir J. J. Thomson (Cambridge) gave a lecture illustrated by experiments on "Multiply Charged Atoms," in which he described some recent investigations on positive charges. He explained the parabolic grouping effected by the simultaneous action of electric and magnetic fields, and showed photographs of the parabolic arcs obtained in various particular cases. In the case of mercury atoms, eight such arcs were obtained, due to one or more of the charges originally carried being lost in transit, so that the particles arrived at the screen with their original energy but with reduced charge.

At an ordinary meeting of Section IV, Dr. A. N. Whitehead (London) read a paper on the principles of mathematics in relation to elementary teaching. The only justification for the inclusion of mathematics in a liberal education is the power of abstraction and deductive reasoning fostered thereby. These powers can only be acquired by constant practice, and no short-cuts are possible. But this does not imply that such powers are to be assumed in the pupil from the outset. On the contrary, no generalisation can be made by the pupil until he is familiar with the raw material from which it is to be made. There is no final degree of rigour in deduction, and the degree to be adopted is a matter for the teacher to decide. His personal choice would be approximately the degree of rigour, though not necessarily the content of Euclid's Elements. No compromise is desirable between the purely utilitarian procedure of looking up a formula in an engineering pocket-book and the acquisition of a mathematical habit of mind by years of practice in abstraction and deduction.

Mr. G. E. St. L. Carson (Tonbridge) read a paper on the place of deduction in elementary mechanics. He suggested that, besides the old method of teaching mechanics in which a structure of deduction was raised on a few postulated laws, and the new method in which principles are demonstrated independently by experiment, there is a third method possible in which the logical interdependence of the principles demonstrated is discussed. Not only is this an aid to understanding the foundations of the subject, but they are shown to constitute a broad inductive basis.

A paper by Dr. T. P. Nunn (London) was read on the proper scope and method of instruction in the calculus in schools. He advocated the teaching of integration by means of graphical illustration on the lines originally adopted by Wallis. This should be followed by a consideration of differentiation as the converse geometrical problem. The teacher should avoid all use of such mystic phrases as "infinite" and "ultimately become," keeping carefully to the definition of limit in terms of finite quantities.

At meetings of Section IV (*b*), in conjunction with the International Commission on the Teaching of Mathematics, reports were presented, with a few explanatory remarks, by delegates from twenty-one countries. The reports exceeded 280 in number, forming an aggregate of more than 9000 octavo pages. These may be obtained from Messrs. Georg et Cie., of Geneva; the English reports have recently been issued in two volumes by the Board of Education. The commission was reappointed for a further period of four years, in order that a digest of these reports may be prepared for the use of teachers in each country. The commission has also conducted special investigations, and reports were presented on the results of two of these.

Prof. C. Runge (Göttingen) presented a report on the mathematical training of the physicist in the university. The need for the closer co-operation of the mathematician and the physicist is strongly felt. It would be of benefit not only to the future physicist or engineer, but also to the student of pure mathematics, if in mathematical lectures theoretical solutions were followed up by numerical computations and applications to material problems. It is also felt that mathematical teaching in the university would be improved if the lecturer were assisted by demonstrators who could keep in personal touch with the student, and aid him as difficulties arise. In commenting on this report, Profs. Hobson, Love, and Sir J. Larmor were of opinion that to limit the mathematics of science students to those portions which might be considered of direct utility would destroy that logical unity which is the essential feature of the subject, and relegate it to a subservient position little in keeping with its importance. Sir A. G. Greenhill uttered a warning against the excessive attention engineering pupils are apt to give to descriptive geometry, to the detriment of their studies in the calculus. Sir J. J. Thomson was in favour of physicists learning mathematics from pure mathematicians, if the latter would reserve some of their latest refinements for special lectures.

Prof. D. E. Smith (New York) presented a report on intuition and experiment in mathematical teaching in secondary schools. The object of the inquiry was to ascertain to what extent intuitional methods are at present employed. A general spirit of unrest is apparent. In geometry it may be said that it is the plan of the Teutonic countries to mix the intuitional and deductive work from the outset, while in France, and now in England, the plan is to let an inductive cycle precede a deductive one. The United States is only beginning to talk about the question, whatever tendency there is being towards the Anglo-French plan. The second important movement is the elaboration of the function concept; starting in France within the last twenty years, and vigorously advocated in Germany within the last decade, the movement is, as a whole, too recent to judge of its permanence. A practical form of outdoor mensuration seems to be developing, especially in Austria, Germany, and Switzerland. Geometric drawing and the graphic representation of solids are passing from the hands of the art teacher to the mathematician. Graphic methods of representing functions have become universal in the last generation. The contracted methods of computation that were prominently advocated fifty years ago do not seem to have advanced materially, owing to the feeling that they are not really practical; on the other hand, logarithms have come into general use, and the slide rule is in great favour in technical schools. In general, it may be said that intuitional and experimental methods have made more progress in Austria, Germany, and Switzerland than in England, France, and the United States.

At the final meeting of the congress it was resolved to accept the invitation to Stockholm for the next meeting in 1916. Informal invitations to Budapest and Athens for subsequent meetings were also noted.

THE BRITISH ASSOCIATION AT DUNDEE.

BY the time this issue reaches the reader the British Association will be in full session, and meanwhile there seems to be every prospect of an unusually successful meeting. Dundee is a town of comparatively small population, largely made up of the working classes, but the number of persons resident in the town and neighbourhood who have joined the Association is remarkable. The various towns in which the Association meets are found to differ greatly in this respect, and it occasionally happens that the number of local associates is exceedingly small. Since the year 1901 the Association has held its annual meetings on two occasions abroad and on nine occasions at places within the United Kingdom. The average number of tickets sold at these nine centres before the opening of the reception rooms is 460, and the highest number so sold at any one of the nine was 643; but considerably more than 1100 tickets had already been sold in Dundee by the local committee before the opening of the reception rooms, and by Tuesday evening some 2000 tickets were issued.

This large local addition to the ordinary membership of the Association, together with the unusually large attendance of foreign, American, and Colonial guests, however gratifying it may be to the officers of the Association, renders the task of the local committee a difficult and anxious one. The various halls and Section rooms will be taxed to the utmost, and the various excursions and entertainments will scarcely be sufficient for an attendance so greatly in excess of the estimates that were based on the statistics of recent meetings.

As has already been stated in these columns, the attendance of scientific men from abroad is unusually great, beyond anything indeed that has been seen since the great meeting at Manchester; and this large gathering of foreigners has had its effect in helping to attract the scientific men of our own country. Within the last few days a number of eminent mathematicians, who have attended the recent congress at Cambridge, have made known their intention to be present; geologists are mustering in strength from many countries, tempted to a large extent by the promise of excursions of unusual interest, and a still larger gathering of notable physiologists are coming to do honour to a physiological President.

Every nook and corner of the town is filled almost to overflowing, and members who arrive without having made their arrangements beforehand will have little chance of finding even the simplest houseroom. Private hospitality has provided for between 700 and 800 guests, and every hotel in the town and in the near neighbourhood was filled up many days ago.

It is sometimes said that the British Association is losing ground, but the experience of this meeting shows that the belief is without foundation; not only is the attendance this year fully comparable to the average attendance in the best days of the Association, but there is every prospect also of animated discussion and abundant scientific work. We print this week the inaugural address delivered last night by the president, Prof. E. A. Schäfer, F.R.S., and also the address to be delivered by Prof. H. L. Callendar, F.R.S., before Section A this morning. Other addresses, and reports of the proceedings of the various Sections, will appear in later issues.

INAUGURAL ADDRESS BY PROF. E. A. SCHÄFER, LL.D., D.Sc., M.D., F.R.S., PRESIDENT.

Introductory.

IT is exactly forty-five years ago—to the day and hour—that the British Association last met in this city and in this hall to listen to a Presidential Address. The President was the Duke of Buccleuch; the General Secretaries, Francis Galton and T. Archer Hirst; the General Treasurer, William Spottiswoode; and the Assistant General Secretary, George Griffith, who was for many years a mainstay of the Association. The Evening Discourses were delivered by John Tyndall "On Matter and Force," by Archibald Geikie "On the Geological Origin of the Scenery of Scotland," and by Alexander Herschel "On the Present State of Knowledge regarding Meteors and Meteorites." The Presidents of Sections, which were then only seven in number, were for Mathematics and Physics, Sir William Thomson—later to be known as Lord Kelvin; for Chemistry, Thomas Anderson; for Geology, Archibald Geikie, who now as President of the Royal Society worthily fills the foremost place in science within the realm; for Biology, William Sharpey, my own revered master, to whose teaching and influence British physiology largely owes the honourable position which it at present occupies; for Geography, Sir Samuel Baker, the African explorer, who with his intrepid wife was the first to follow the Nile to its exit from the Albert Nyanza; for Economic Science, Mr. Grant Duff; and for Mechanical Science, Professor Rankine.

Other eminent men present were Sir David Brewster, J. Clerk Maxwell, Charles Wheatstone, Balfour Stewart, William Crookes, J. B. Lawes and J. H. Gilbert (names inseparable in the history of agricultural science), Crum Brown, G. D. Liveing, W. H. Russell, Alexander Williamson, Henry Alleyne Nicholson, William Allmann, John Hutton Balfour, Spencer Cobbold, Anton Dohrn, Sir John Lubbock (now Lord Avebury), William McIntosh, E. Ray Lankester, C. W. Peach, William Pengelly, Hughes Bennett, John Cleland, John Davy, Alexander Christison, Alfred Russel Wallace, Allen Thomson, William Turner, George Busk, Michael Foster (not yet founder of the Cambridge School of Physiology), Henry Howorth, Sir Roderick Murchison, Clements R. Markham, Sir William (afterwards Lord) Armstrong, and Douglas Galton. Many of those enumerated have in the course of nature passed away from us, but not a few remain, and we are glad to know that most of these retain their ancient vigour in spite of the five-and-forty years which separate us from the last meeting in this place.

Selection of Subject of Address.

For the Address with which it is usual for the President to open the proceedings of the annual assembly, the field covered by the aims of the British Association provides the widest possible range of material from which to select. One condition alone is prescribed by custom, viz., that the subject chosen shall lie within the bounds of those branches of knowledge which are dealt with in the Sections. There can be no ground of complaint regarding this limitation on the score of variety, for within the forty years that I have myself been present (not, I regret to say, without a break) at these gatherings, problems relating to the highest mathematics on the one hand, and to the most utilitarian applications of science on the other, with every possible gradation between these extremes, have been discussed before us by successive Presidents; and the addition from time to time of new Sections (one of which, that of Agriculture, we welcome at this Meeting) enables the whilom occupant of this chair to traverse paths which have not been previously trodden by his predecessors. On the last two occasions, under the genial guidance of Profs. Bonney and Sir William Ramsay, we have successively been taken in imagination to the glaciers which flow between the highest peaks of the Alps and into the bowels of the earth; where we were invited to contemplate the prospective disappearance of the material upon which all our industrial prosperity depends. Needless to say that the lessons to be drawn from our visits to those unaccustomed levels were placed before us with all the eloquence with which these eminent representatives of Geology and Chemistry are gifted. It is fortunately not expected that I should be able to soar to such heights or to plunge to such depths, for the branch of science with which I am personally associated is merely concerned with the investigation of the problems of living beings, and I am able to invite you to remain for an hour or so at the level of ordinary mortality to consider certain questions which at any rate cannot fail to have an immediate interest for everyone present, seeing that they deal with the nature, origin, and maintenance of life.

Definition.

Everybody knows, or thinks he knows, what life is; at least, we are all acquainted with its ordinary, obvious manifestations. It would, therefore, seem that it should not be difficult to find an exact definition. The quest has nevertheless baffled the most acute thinkers. Herbert Spencer devoted two chapters of his "Principles of Biology" to the discussion of the attempts at definition which had up to that date been proposed, and himself suggested another. But at the end of it all he is constrained to admit that no expression had been found which would embrace all the known manifestations of animate, and at the same time exclude those of admittedly inanimate, objects.

The ordinary dictionary definition of life is "the state of living." Dastre, following Claude Bernard, defines it as "the sum total of the phenomena common to all living beings."[1] Both of these definitions are, however, of the same character as Sydney Smith's definition of an archdeacon as "a person who performs archidiaconal functions." I am not myself proposing to take up your time by attempting to grapple with a task which has proved too great for the intellectual giants of philosophy, and I have the less disposition to do so because recent advances in knowledge have suggested the probability that the dividing line between animate and inanimate matter is less sharp than it has hitherto been regarded, so that the difficulty of finding an inclusive definition is correspondingly increased.

Life not Identical with Soul.

As a mere word "life" is interesting in the fact that it is one of those abstract terms which has no direct antithesis; although probably most persons would regard "death" in that light. A little consideration will show that this is not the case. "Death" implies the pre-existence of "life"; there are physiological grounds for regarding death as a phenomenon of life—it is the completion, the last act of life. We cannot speak of a non-living object as *possessing* death in the sense that we speak of a living object as *possessing* life. The adjective "dead" is, it is true, applied in a popular sense antithetically to objects which have never possessed life; as in the proverbial expression "as dead as a door-nail." But in the strict sense such application is not justifiable, since the use of the terms dead and living implies either in the past or in the present the possession of the recognised properties of living matter. On the other hand, the expressions *living* and *lifeless*, *animate* and *inanimate*, furnish terms which are undoubtedly

1 "La vie et la mort," English translation by W. J. Greenstreet, 1911, p. 54

antithetical. Strictly and literally, the words animate and inanimate express the presence or absence of "soul"; and not infrequently we find the terms "life" and "soul" erroneously employed as if identical. But it is scarcely necessary for me to state that the remarks I have to make regarding "life" must not be taken to apply to the conception to which the word "soul" is attached.

Problems of Life are Problems of Matter.

The fact that the formation of such a conception is only possible in connection with life, and that the growth and elaboration of the conception has only been possible as the result of the most complex processes of life in the most complex of living organisms, has doubtless led to a belief in the identity of life with soul. But unless the use of the expression "soul" is extended to a degree which would deprive it of all special significance, the distinction between these terms must be strictly maintained. For the problems of life are essentially problems of matter; we cannot conceive of life in the scientific sense as existing apart from matter. The phenomena of life are investigated, and can only be investigated, by the same methods as all other phenomena of matter, and the general results of such investigations tend to show that living beings are governed by laws identical with those which govern inanimate matter. The more we study the manifestations of life, the more we become convinced of the truth of this statement and the less we are disposed to call in the aid of a special and unknown form of energy to explain those manifestations.

Phenomena Indicative of Life: Movement.

The most obvious manifestation of life is "spontaneous" movement. We see a man, a dog, a bird move, and we know that they are alive. We place a drop of pond water under the microscope, and see numberless particles rapidly moving within it; we affirm that it swarms with "life." We notice a small mass of clear slime changing its shape, throwing out projections of its structureless substance, creeping from one part of the field of the microscope to another. We recognise that the slime is living; we give it a name—*Amoeba limax*—the slug amœba. We observe similar movements in individual cells of our own body; in the white corpuscles of our blood, in connective tissue cells, in growing nerve cells, in young cells everywhere. We denote the similarity between these movements and those of the amœba by employing the descriptive term "amœboid" for both. We regard such movements as indicative of the possession of "life"; nothing seems more justifiable than such an inference.

Similarity of Movements in Living and Non-living Matter.

But physicists [2] show us movements of a precisely similar character in substances which no one by any stretch of imagination can regard as living; movements of oil drops, of organic and inorganic mixtures, even of mercury globules, which are indistinguishable in their character from those of the living organisms we have been studying: movements which can only be described by the same term amœboid, yet obviously produced as the result of purely physical and chemical reactions causing changes in surface tension of the fluids under examination.[3] It is therefore certain that such movements are not specifically "vital," that their presence does not necessarily denote "life." And when we investigate closely even such active movements as those of a vibratile cilium or a phenomenon so closely identified with life as the contraction of a muscle, we find that these present so many analogies with amœboid movements as to render it certain that they are fundamentally of the same character and produced in much the same manner.[4] Nor can we for a moment doubt that the complex actions which are characteristic of the more highly differentiated organisms have been developed in the course of evolution from the simple movements characterising the activity of undifferentiated protoplasm; movements which can themselves, as we have seen, be perfectly imitated by non-living material. The chain of evidence regarding this particular manifestation of life—movement—is complete. Whether exhibited as the amœboid movement of the proteus animalcule or of the white corpuscle of our blood; as the ciliary motion of the infusorian or of the ciliated cell; as the contraction of a muscle under the governance of the will, or as the throbbing of the human heart responsive to every emotion of the mind, we cannot but conclude that it is alike subject to and produced in conformity with the general laws of matter, by agencies resembling those which cause movements in lifeless material.[5]

Assimilation and Disassimilation.

It will perhaps be contended that the resemblances between the movements of living and non-living matter may be only superficial, and that the conclusion regarding their identity to which we are led will be dissipated when we endeavour to penetrate more deeply into the working of living substance. For can we not recognise along with the possession of movement the presence of other phenomena which are equally characteristic of life and with which non-living material is not endowed? Prominent among the characteristic phenomena of life are the processes of assimilation and disassimilation, the taking in of food and its elaboration.[6] These, surely, it may be thought, are not shared by matter which is not endowed with life. Unfortunately for this argument, similar processes occur characteristically in situations which no one would think of associating with the presence of life. A striking example of this is afforded by the osmotic phenomena presented by solutions separated from one another by semipermeable membranes or films, a condition which is precisely that which is constantly found in living matter.[7]

Chemical Phenomena accompanying Life.

It is not so long ago that the chemistry of organic matter was thought to be entirely different from that of inorganic substances. But the line between inorganic and organic chemistry, which up to the middle of the last century appeared sharp, subsequently

[2] G. Quincke, "Annal. d. Physik. v. Chem.," 1870 and 1888.

[3] The causation not only of movements but of various other manifestations of life by alterations in surface tension of living substance is ably dealt with by A. B. Macallum in a recent article in Asher and Spiro's "Ergebnisse der Physiologie," 1911. Macallum has described an accumulation of potassium salts at the more active surfaces of the protoplasm of many cells, and correlates this with the production of cell-activity by the effect of such accumulation upon the surface tension. The literature of the subject will be found in this article.

[4] G. F. Fitzgerald (Brit. Assoc. Reports, 1898, and Scient. Trans. Roy Dublin Society, 1898) arrived at this conclusion with regard to muscle from purely physical considerations.

[5] "Vital spontaneity, so readily accepted by persons ignorant of biology, is disproved by the whole history of science. Every vital manifestation is a response to a stimulus, a provoked phenomenon. It is unnecessary to say this is also the case with brute bodies, since that is precisely the foundation of the great principle of the inertia of matter. It is plain that it is also as applicable to living as to inanimate matter."—Dastre, *op. cit.*, p. 280

[6] The terms "assimilation" and "disassimilation" express the physical and chemical changes which occur within protoplasm as the result of the intake of nutrient material from the circumambient medium and its ultimate transformation into waste products which are passed out again into that medium; the whole cycle of these changes being embraced under the term "metabolism."

[7] Leduc ("The Mechanism of Life," English translation by W. Deane Butcher, 1911) has given many illustrations of this statement. In the Report of the meeting of 1867 in Dundee is a paper by Dr. J. D Heaton (On Simulations of Vegetable Growths by Mineral Substances) dealing with the same class of phenomena. The conditions of osmosis *in* cells have been especially studied by Hamburger ("Osmotischer Druck und Ionenlehre," (Wiesbaden, 1902-4).

became misty and has now disappeared. Similarly the chemistry of living organisms, which is now a recognised branch of organic chemistry, but used to be considered as so much outside the domain of the chemist that it could only be dealt with by those whose special business it was to study "vital" processes, is passing every day more out of the hands of the biologist and into those of the pure chemist.

The Colloid Constitution of Living Matter.—Identity of Physical and Chemical Processes in Living and Non-living Matter.

Somewhat more than half a century ago Thomas Graham published his epoch-making observations relating to the properties of matter in the colloidal state: observations which are proving all-important in assisting our comprehension of the properties of living substance. For it is becoming every day more apparent that the chemistry and physics of the living organism are essentially the chemistry and physics of nitrogenous colloids. Living substance or protoplasm always, in fact, takes the form of a colloidal solution. In this solution the colloids are associated with crystalloids (electrolytes), which are either free in the solution or attached to the molecules of the colloids. Surrounding and enclosing the living substance thus constituted of both colloid and crystalloid material is a film, probably also formed of colloid, but which may have a lipoid substratum associated with it (Overton). This film serves the purpose of an osmotic membrane, permitting of exchanges by diffusion between the colloidal solution constituting the protoplasm and the circumambient medium in which it lives. Other similar films or membranes occur in the interior of protoplasm. These films have in many cases specific characters, both physical and chemical, thus favouring the diffusion of special kinds of material into and out of the protoplasm and from one part of the protoplasm to another. It is the changes produced under these physical conditions, associated with those caused by active chemical agents formed within protoplasm and known as *enzymes*, that effect assimilation and disassimilation. Quite similar changes can be produced outside the body (*in vitro*) by the employment of methods of a purely physical and chemical nature. It is true that we are not yet familiar with all the intermediate stages of transformation of the materials which are taken in by a living body into the materials which are given out from it. But since the initial processes and the final results are the same as they would be on the assumption that the changes are brought about in conformity with the known laws of chemistry and physics, we may fairly conclude that all changes in living substance are brought about by ordinary chemical and physical forces.

Similarity of the Processes of Growth and Reproduction in Living and Non-living Matter.

Should it be contended that growth and reproduction are properties possessed only by living bodies and constitute a test by which we may differentiate between life and non-life, between the animate and inanimate creation, it must be replied that no contention can be more fallacious. Inorganic crystals grow and multiply and reproduce their like, given a supply of the requisite pabulum. In most cases for each kind of crystal there is, as with living organisms, a limit of growth which is not exceeded, and further increase of the crystalline matter results not in further increase in size but in multiplication of similar crystals. Leduc has shown that the growth and division of artificial colloids of an inorganic nature, when placed in an appropriate medium, present singular resemblances to the phenomena of the growth and division of living organisms. Even so complex a process as the division of a cell-nucleus by karyokinesis as a preliminary to the multiplication of the cell by division—a phenomenon which would *primâ facie* have seemed and has been commonly regarded as a distinctive manifestation of the life of the cell—can be imitated with solutions of a simple inorganic salt, such as chloride of sodium, containing a suspension of carbon particles; which arrange and rearrange themselves under the influence of the movements of the electrolytes in a manner indistinguishable from that adopted by the particles of chromatin in a dividing nucleus. And in the process of sexual reproduction, the researches of J. Loeb and others upon the ova of the sea-urchin have proved that we can no longer consider such an apparently vital phenomenon as the fertilisation of the egg as being the result of living material brought to it by the spermatozoon, since it is possible to start the process of the ovum and the resulting formation of cells, and ultimately of all the tissues and organs—in short, to bring about the development of the whole body—if a simple chemical reagent is substituted for the male element in the process of fertilisation. Indeed, even a mechanical or electrical stimulus may suffice to start development.

The Question of Vitalism and Vital Force.

Kurz und gut, as the Germans say, vitalism as a working hypothesis has not only had its foundations undermined, but most of the superstructure has toppled over, and if any difficulties of explanation still persist, we are justified in assuming that the cause is to be found in our imperfect knowledge of the constitution and working of living material. At the best vitalism explains nothing, and the term "vital force" is an expression of ignorance which can bring us no further along the path of knowledge. Nor is the problem in any way advanced by substituting for the term "vitalism" "neo-vitalism," and for "vital force" "biotic energy."[8] "New presbyter is but old priest writ large."

The Possibility of the Synthesis of Living Matter.

Further, in its chemical composition we are no longer compelled to consider living substance as possessing infinite complexity, as was thought to be the case when chemists first began to break up the proteins of the body into their simpler constituents. The researches of Miescher, which have been continued and elaborated by Kossel and his pupils, have acquainted us with the fact that a body so important for the nutritive and reproductive functions of the cell as the nucleus—which may be said indeed to represent the quintessence of cell-life—possesses a chemical constitution of no very great complexity; so that we may even hope some day to see the material which composes it prepared synthetically. And when we consider that the nucleus is not only itself formed of living substance, but is capable of causing other living substance to be built up; is, in fact, the directing agent in all the principal chemical changes which take place within the living cell, it must be admitted that we are a long step forward in our knowledge of the chemical basis of life. That it is the *form* of nuclear matter rather than its chemical and molecular structure which is the important factor in nuclear activity cannot be supposed. The form of nuclei, as every microscopist knows, varies infinitely, and there are numerous living organisms in which the nuclear matter is without form, appearing simply as granules distributed in the protoplasm. Not that the form assumed and the

[8] B. Moore, in "Recent Advances in Physiology," 1906; Moore and Roaf, *ibid.*; and "Further Advances in Physiology," 1909. Moore lays especial stress on the transformations of energy which occur in protoplasm. See on the question of vitalism Gley (*Revue Scientifique*, 1911) and D'Arcy Thompson (Address to Section D at Portsmouth, 1911).

transformations undergone by the nucleus are without importance; but it is none the less true that even in an amorphous condition the material which in the ordinary cell takes the form of a "nucleus" may, in simpler organisms which have not in the process of evolution become complete cells, fulfil functions in many respects similar to those fulfilled by the nucleus of the more differentiated organism.

A similar anticipation regarding the probability of eventual synthetic production may be made for the proteins of the cell-substance. Considerable progress in this direction has indeed already been made by Emil Fischer, who has for many years been engaged in the task of building up the nitrogenous combinations which enter into the formation of the complex molecule of protein. It is satisfactory to know that the significance of the work both of Fischer and of Kossel in this field of biological chemistry has been recognised by the award to each of these distinguished chemists of a Nobel prize.

The Chemical Constitution of Living Substance.

The elements composing living substance are few in number. Those which are constantly present are carbon, hydrogen, oxygen, and nitrogen. With these, both in nuclear matter and also, but to a less degree, in the more diffuse living material which we know as protoplasm, phosphorus is always associated. "Ohne Phosphor kein Gedank" is an accepted aphorism; "Ohne Phosphor kein Leben" is equally true. Moreover, a large proportion, rarely less than 70 per cent., of water appears essential for any manifestation of life, although not in all cases necessary for its continuance, since organisms are known which will bear the loss of the greater part if not the whole of the water they contain without permanent impairment of their vitality. The presence of certain inorganic salts is no less essential, chief amongst them being chloride of sodium and salts of calcium, magnesium, potassium, and iron. The combination of these elements into a colloidal compound represents the chemical basis of life; and when the chemist succeeds in building up this compound it will without doubt be found to exhibit the phenomena which we are in the habit of associating with the term "life."[9]

Source of Life. The Possibility of Spontaneous Generation.

The above considerations seem to point to the conclusion that the possibility of the production of life—*i.e.*, of living material—is not so remote as has been generally assumed. Since the experiments of Pasteur, few have ventured to affirm a belief in the spontaneous generation of bacteria and monads and other micro-organisms, although before his time this was by many believed to be of universal occurrence. My esteemed friend Dr. Charlton Bastian is, so far as I am aware, the only scientific man of eminence who still adheres to the old creed, and Dr. Bastian, in spite of numerous experiments and the publication of many books and papers, has not hitherto succeeded in winning over any converts to his opinion. I am myself so entirely convinced of the accuracy of the results which Pasteur obtained—are they not within the daily and hourly experience of everyone who deals with the sterilisation of organic solutions?—that I do not hesitate to believe, if living torulæ or mycelia are exhibited to me in flasks which had been subjected to prolonged boiling after being hermetically sealed, that there has been some fallacy either in the premisses or in the carrying out of the operation. The appearance of organisms in such flasks would not furnish to my mind proof that they were the result of spontaneous generation. Assuming no fault in manipulation or fallacy in observation, I should find it simpler to believe that the germs of such organisms have resisted the effects of prolonged heat than that they became generated spontaneously. If spontaneous generation is possible, we cannot expect it to take the form of living beings which show so marked a degree of differentiation, both structural and functional, as the organisms which are described as making their appearance in these experimental flasks.[10] Nor should we expect the spontaneous generation of living substance of any kind to occur in a fluid the organic constituents of which have been so altered by heat that they can retain no sort of chemical resemblance to the organic constituents of living matter. If the formation of life—of living substance—is possible at the present day—and for my own part I see no reason to doubt it—a boiled infusion of organic matter—and still less of inorganic matter—is the last place in which to look for it. Our mistrust of such evidence as has yet been brought forward need not, however, preclude us from admitting the possibility of the formation of living from non-living substance.[11]

Life a Product of Evolution.

Setting aside, as devoid of scientific foundation, the idea of immediate supernatural intervention in the first production of life, we are not only justified in believing, but compelled to believe, that living matter must have owed its origin to causes similar in character to those which have been instrumental in producing all other forms of matter in the universe; in other words, to a process of gradual evolution.[12] But it has been customary of late amongst biologists to shelve the investigation of the mode of origin of life by evolution from non-living matter by relegating its solution to some former condition of the earth's history, when, it is assumed, opportunities were accidentally favourable for the passage of inanimate matter into animate; such opportunities, it is also assumed, having never since recurred and being never likely to recur.[13]

Various eminent scientific men have even supposed that life has not actually originated upon our globe, but has been brought to it from another planet or from another stellar system. Some of my audience may still remember the controversy that was excited when the theory of the origin of terrestial life by the intermediation of a meteorite was propounded by Sir William Thomson in his Presidential Address at the

9 The most recent account of the chemistry of protoplasm is that by Botazzi ("Das Cytoplasma u. die Körpersäfte") in Winterstein's "Handb. d. vergl. Physiologie," Bd. I., 1912. The literature is given in this article.

10 It is fair to point out that Dr. Bastian suggests that the formation of ultramicroscopic living particles may precede the appearance of the microscopic organisms which he describes. "The Origin of Life," 1911, p. 65.

11 The present position of the subject is succinctly stated by Dr. Chalmers Mitchell in his article on "Abiogenesis" in the "Encyclopædia Britannica." Dr. Mitchell adds "It may be that in the progress of science it may yet be possible to construct living protoplasm from non living material. The refutation of abiogenesis has no further bearing on this possibility than to make it probable that if protoplasm ultimately be formed in the laboratory, it will be by a series of steps, the earlier steps being the formation of some substance, or substances now unknown, which are not protoplasm. Such intermediate stages may have existed in the past." And Huxley in his Presidential Address at Liverpool in 1870 says: "But though I cannot express this conviction" (*i.e.*, of the impossibility of the occurrence of abiogenesis as exemplified by the appearance of organisms in hermetically sealed and sterilised flasks) "too strongly, I must carefully guard myself against the supposition that I intend to suggest that no such thing as abiogenesis ever has taken place in the past or ever will take place in the future. With organic chemistry, molecular physics and physiology yet in their infancy and every day making prodigious strides, I think it would be the height of presumption for any man to say that the conditions under which matter assumes the properties we call "vital" may not, some day, be artificially brought together."

12 The arguments in favour of this proposition have been arrayed by Meldola in his Herbert Spencer Lecture, 1910, pp. 16–24. Meldola leaves the question open whether such evolution has occurred only in past years or is also taking place now. He concludes that whereas certain carbon compounds have survived by reason of possessing extreme stability, others—the precursors of living matter survived owing to the possession of extreme lability and adaptability to variable conditions of environment. A similar suggestion was previously made by Lockyer, "Inorganic Evolution," 1900, pp. 169, 170.

13 T. H. Huxley, Presidential Address, 1870; A. B. Macallum, "On the Origin of Life on the Globe," in Trans. Canadian Institute, VIII.

meeting of this Association in Edinburgh in 1871. To this "meteorite" theory[14] the apparently fatal objection was raised that it would take some sixty million years for a meteorite to travel from the nearest stellar system to our earth, and it is inconceivable that any kind of life could be maintained during such a period. Even from the nearest planet 150 years would be necessary, and the heating of the meteorite in passing through our atmosphere and at its impact with the earth would, in all probability, destroy any life which might have existed within it. A cognate theory, that of *cosmic panspermia*, assumes that life may exist and may have existed indefinitely in cosmic dust in the interstellar spaces (Richter, 1865; Cohn, 1872), and may with this dust fall slowly to the earth without undergoing the heating which is experienced by a meteorite. Arrhenius,[15] who adopts this theory, states that if living germs were carried through the ether by luminous and other radiations the time necessary for their transportation from our globe to the nearest stellar system would be only nine thousand years, and to Mars only twenty days!

But the acceptance of such theories of the arrival of life on the earth does not bring us any nearer to a conception of its actual mode of origin; on the contrary, it merely serves to banish the investigation of the question to some conveniently inaccessible corner of the universe and leaves us in the unsatisfactory position of affirming not only that we have no knowledge as to the mode of origin of life—which is unfortunately true—but that we never can acquire such knowledge—which it is to be hoped is not true.[16] Knowing what we know, and believing what we believe, as to the part played by evolution in the development of terestrial matter, we are, I think (without denying the possibility of the existence of life in other parts of the universe[17]), justified in regarding these cosmic theories as inherently improbable—at least in comparison with the solution of the problem which the evolutionary hypothesis offers.[18]

The Evolutionary Hypothesis as applied to the Origin of Life.

I assume that the majority of my audience have at least a general idea of the scope of this hypothesis, the general acceptance of which has within the last sixty years altered the whole aspect not only of biology, but of every other branch of natural science, including astronomy, geology, physics, and chemistry.[19] To those who have not this familiarity I would recommend the perusal of a little book by Prof. Judd entitled "The Coming of Evolution," which has recently appeared as one of the Cambridge manuals. I know of no similar book in which the subject is as clearly and succinctly treated. Although the author nowhere expresses the opinion that the actual origin of life on the earth has arisen by evolution from non-living matter, it is impossible to read either this or any similar exposition in which the essential unity of the evolutionary process is insisted upon without concluding that the origin of life must have been due to the same process, this process being, without exception, continuous, and admitting of no gap at any part of its course. Looking, therefore, at the evolution of living matter by the light which is shed upon it from the study of the evolution of matter in general, we are led to regard it as having been produced, not by a sudden alteration, whether exerted by natural or supernatural agency, but by a gradual process of change from material which was lifeless, through material on the borderland between inanimate and animate, to material which has all the characteristics to which we attach the term "life." So far from expecting a sudden leap from an inorganic, or at least an unorganised, into an organic and organised condition, from an entirely inanimate substance to a completely animate state of being, should we not rather expect a gradual procession of changes from inorganic to organic matter, through stages of gradually increasing complexity until material which can be termed living is attained? And in place of looking for the production of fully formed living organisms in hermetically sealed flasks, should we not rather search Nature herself, under natural conditions, for evidence of the existence, either in the past or in the present, of transitional forms between living and non-living matter?

The difficulty, nay, the impossibility, of obtaining evidence of such evolution from the past history of the globe is obvious. Both the hypothetical transitional material and the living material which was originally evolved from it may, as Macallum has suggested, have taken the form of diffused ultramicroscopic particles of living substance[20]; and even if they were not diffused but aggregated into masses, these masses could have been physically nothing more than colloidal watery slime which would leave no impress upon any geological formation. Myriads of years may have elapsed before some sort of skeleton in the shape of calcareous or siliceous spicules began to evolve itself, and thus enabled "life," which must already have possessed a prolonged existence, to make any sort of geological record. It follows that in attempting to pursue the evolution of living matter to its beginning in terrestrial history we can only expect to be confronted with a blank wall of nescience.

The problem would appear to be hopeless of ultimate solution if we are rigidly confined to the supposition that the evolution of life has only occurred once in the past history of the globe. But are we justified in assuming that at one period only, and as it were by a fortunate and fortuitous concomitation of substance and circumstance, living matter became evolved out of non-living matter—life became established? Is there any valid reason to conclude that at some previous period of its history our earth was more favourably circumstanced for the production of life than it is now?[21] I have vainly sought for such reason, and if none be forthcoming the conclusion forces itself upon us that the evolution of non-living into living substance has happened more than once—and we can be by no means sure that it may not be happening still.

14 First suggested, according to Dastre, by de Salles-Guyon (Dastre, *op. cit.*, p. 252). The theory received the support of Helmholtz.

15 "Worlds in the Making," transl. by H. Borns, chap. viii., p. 221, 1908.

16 "The history of science shows how dangerous it is to brush aside mysteries—*i.e.*, unsolved problems—and to interpose the barrier placarded 'eternal—no thoroughfare.'"—R. Meldola, Herbert Spencer Lecture, 1910.

17 Some authorities, such as Errera, contend, with much probability, that the conditions in interstellar space are such that life, as we understand it, could not possibly exist there.

18 As Verworn points out, such theories would equally apply to the origin of any other chemical combination, whether inorganic or organic, which is met with on our globe, so that they lead directly to absurd conclusions.—"Allgemeine Physiologie," 1911.

19 As Meldola insists, this general acceptance was in the first instance largely due to the writings of Herbert Spencer: "We are now prepared for evolution in every domain . . . As in the case of most great generalisations, thought had been moving in this direction for many years. . . . Lamarck and Buffon had suggested a definite mechanism of organic development, Kant and Laplace a principle of celestial evolution, while Lyell had placed geology upon an evolutionary basis. The principle of continuity was beginning to be recognised in physical science. . . . It was Spencer who brought these independent lines of thought to a focus, and who was the first to make any systematic attempt to show that the law of development expressed in its widest and most abstract form was universally followed throughout cosmical processes, inorganic, organic, and super-organic."—*Op. cit.*, p. 14.

20 There still exist in fact forms of life which the microscope cannot show us (E. A. Minchin, Presidential Address to Quekett Club, 1911), and germs which are capable of passing through the pores of a Chamberland filter.

21 Chalmers Mitchell (Article "Life," "Encycl. Brit.," eleventh edition) writes as follows: "It has been suggested from time to time that conditions very unlike those now existing were necessary for the first appearance of life, and must be repeated if living matter is to be reconstituted artificially. No support for such a view can be derived from observations of the existing conditions of life."

It is true that up to the present there is no evidence of such happening; no process of transition has hitherto been observed. But, on the other hand, is it not equally true that the kind of evidence which would be of any real value in determining this question has not hitherto been looked for? We may be certain that if life is being produced from non-living substance, it will be life of a far simpler character than any that has yet been observed—in material which we shall be uncertain whether to call animate or inanimate, even if we are able to detect it at all, and which we may not be able to visualise physically even after we have become convinced of its existence.[22] But we can look with the mind's eye and follow in imagination the transformation which non-living matter may have undergone and may still be undergoing to produce living substance. No principle of evolution is better founded than that insisted upon by Sir Charles Lyell, justly termed by Huxley "the greatest geologist of his time," that we must interpret the past history of our globe by the present; that we must seek for an explanation of what has happened by the study of what is happening; that, given similar circumstances, what has occurred at one time will probably occur at another. The process of evolution is universal. The inorganic materials of the globe are continually undergoing transition. New chemical combinations are constantly being formed and old ones broken up; new elements are making their appearance and old elements disappearing.[23] Well may we ask ourselves why the production of living matter alone should be subject to other laws than those which have produced, and are producing, the various forms of non-living matter; why what has happened may not happen. If living matter has been evolved from lifeless in the past, we are justified in accepting the conclusion that its evolution is possible in the present and in the future. Indeed, we are not only justified in accepting this conclusion, we are forced to accept it. When or where such change from non-living to living matter may first have occurred, when or where it may have continued, when or where it may still be occurring, are problems as difficult as they are interesting, but we have no right to assume that they are insoluble.

Since living matter always contains water as its most abundant constituent, and since the first living organisms recognisable as such in the geological series were aquatic, it has generally been assumed that life must first have made its appearance in the depths of the ocean.[24] Is it, however, certain that the assumption that life originated in the sea is correct? Is not the land-surface of our globe quite as likely to have been the nidus for the evolutionary transformation of non-living into living material as the waters which surround it? Within this soil almost any chemical transformation may occur; it is subjected much more than matters dissolved in sea-water to those fluctuations of moisture, temperature, electricity, and luminosity which are potent in producing chemical changes. But whether life, in the form of a simple slimy colloid, originated in the depths of the sea or on the surface of the land, it would be equally impossible for the geologist to trace its beginnings, and were it still becoming evolved in the same situations, it would be almost as impossible for the microscopist to follow its evolution. We are therefore not likely to obtain direct evidence regarding such a transformation of non-living into living matter in nature, even if it is occurring under our eyes.

An obvious objection to the idea that the production of living matter from non-living has happened more than once is that, had this been the case, the geological record should reveal more than one palæontological series. This objection assumes that evolution would in every case take an exactly similar course and proceed to the same goal—an assumption which is, to say the least, improbable. If, as might well be the case, in any other palæontological series than the one with which we are acquainted the process of evolution of living beings did not proceed beyond Protista, there would be no obvious geological evidence regarding it; such evidence would only be discoverable by a carefully directed search made with that particular object in view.[25] I would not by any means minimise the difficulties which attend the suggestion that the evolution of life may have occurred more than once or may still be happening, but, on the other hand, it must not be ignored that those which attend the assumption that the production of life has occurred once only are equally serious. Indeed, had the idea of the possibility of a multiple evolution of living substance been first in the field, I doubt if the prevalent belief regarding a single fortuitous production of life upon the globe would have become established among biologists—so much are we liable to be influenced by the impressions we receive in scientific childhood!

Further Course of Evolution of Life.

Assuming the evolution of living matter to have occurred—whether once only or more frequently matters not for the moment—and in the form suggested, viz., as a mass of colloidal slime possessing the property of assimilation and therefore of growth, reproduction would follow as a matter of course. For all material of this physical nature—fluid or semi-fluid in character—has a tendency to undergo subdivision when its bulk exceeds a certain size. The subdivision may be into equal or nearly equal parts, or it may take the form of buds. In either case every separated part would resemble the parent in chemical and physical properties, and would equally possess the property of taking in and assimilating suitable material from its liquid environment, growing in bulk and reproducing its like by subdivision. *Omne vivum e vivo.* In this way from any beginning of living material a primitive form of life would spread, and would gradually people the globe. The establishment of life being once effected, all forms of organisation follow under the inevitable laws of evolution. *Ce n'est que le premier pas qui coûte.*

We can trace in imagination the segregation of a more highly phosphorised portion of the primitive living matter, which we may now consider to have become more akin to the protoplasm of organisms with which we are familiar. This more phosphorised portion might not for myriads of generations take the form of a definite nucleus, but it would be composed of material having a composition and qualities similar to those of the nucleus of a cell. Prominent among these qualities is that of catalysis—the func-

[22] "Spontaneous generation of life could only be perceptually demonstrated by filling in the long terms of a series between the complex forms of inorganic and the simplest forms of organic substance. Were this done, it is quite possible that we should be unable to say (especially considering the vagueness of our definitions of life) where life began or ended."—K. Pearson, "Grammar of Science," second edition, 1900, p. 350.

[23] See on the production of elements, W. Crookes, Address to Section B, Brit. Assoc., 1886; T. Preston, NATURE, vol. lx., p. 180; J. J. Thomson, *Phil. Mag.*, 1897, p. 311; Norman Lockyer, *op. cit.*, 1900; G. Darwin, Pres. Addr. Brit. Association., 1905.

[24] For arguments in favour of the first appearance of life having been in the sea, see A. B. Macallum, "The Palæochemistry of the Ocean," Trans. Canad. Instit., 1903–4.

[25] Lankester (Art. "Protozoa," "Encycl. Brit.," tenth edition) conceives that the first protoplasm fed on the antecedent steps in its own evolution. F. J. Allen (Brit. Assoc. Reports, 1896) comes to the conclusion that living substance is probably constantly being produced, but that this fails to make itself evident owing to the substance being seized and assimilated by existing organisms. He believes that "in accounting for the first origin of life on this earth it is not necessary that, as Pflüger assumed, the planet should have been at a former period a glowing fire-ball." He "prefers to believe that the circumstances which support life would also favour its origin." And elsewhere: "Life is not an extraordinary phenomenon, not even an importation from some other sphere, but rather the actual outcome of circumstances on this earth."

tion of effecting profound chemical changes in other material in contact with it without itself undergoing permanent change. This catalytic function may have been exercised directly by the living substance or may have been carried on through the agency of the enzymes already mentioned, which are also of a colloid nature but of simpler constitution than itself, and which differ from the catalytic agents employed by the chemist in the fact that they produce their effects at a relatively low temperature. In the course of evolution special enzymes would become developed for adaptation to special conditions of life, and with the appearance of these and other modifications, a process of differentiation of primitive living matter into individuals with definite specific characters gradually became established. We can conceive of the production in this way from originally undifferentiated living substance of simple differentiated organisms comparable to the lowest forms of Protista. But how long it may have taken to arrive at this stage we have no means of ascertaining. To judge from the evidence afforded by the evolution of higher organisms it would seem that a vast period of time would be necessary for even this amount of organisation to establish itself.

Formation of the Nucleated Cell.

The next important phase in the process of evolution would be the segregation and moulding of the diffused or irregularly aggregated nuclear matter into a definite nucleus around which all the chemical activity of the organism will in future be centred. Whether this change were due to a slow and gradual process of segregation or of the nature of a jump, such as Nature does occasionally make, the result would be the advancement of the living organism to the condition of a complete nucleated cell: a material advance not only in organisation, but—still more important—in potentiality for future development. Life is now embodied in the cell, and every living being evolved from this will itself be either a cell or a cell-aggregate. *Omnis cellula e cellulâ.*

Establishment of Sexual Differences.

After the appearance of a nucleus—but how long after it is impossible to conjecture—another phenomenon appeared upon the scene in the occasional exchange of nuclear substance between cells. In this manner became established the process of sexual reproduction. Such exchange in the unicellular Protista might and may occur between any two cells forming the species, but in the multicellular Metazoa it became—like other functions—specialised in particular cells. The result of the exchange is rejuvenescence; associated with an increased tendency to subdivide and to produce new individuals. This is due to the introduction of a stimulating or catalytic chemical agent into the cell which is to be rejuvenated, as is proved by the experiments of Loeb already alluded to. It is true that the chemical material introduced into the germ-cell in the ordinary process of its fertilisation by the sperm-cell is usually accompanied by the introduction of definite morphological elements which blend with others already contained within the germ-cell, and it is believed that the transmission of such morphological elements of the parental nuclei is related to the transmission of parental qualities. But we must not be blind to the possibility that these transmitted qualities may be connected with specific chemical characters of the transmitted elements; in other words, that heredity also is one of the questions the eventual solution of which we must look to the chemist to provide.

Aggregate Life.

So far we have been chiefly considering life as it is found in the simplest forms of living substance, organisms for the most part entirely microscopic and neither distinctively animal nor vegetable, which were grouped together by Haeckel as a separate kingdom of animated nature—that of Protista. But persons unfamiliar with the microscope are not in the habit of associating the term "life" with microscopic organisms, whether these take the form of cells or of minute portions of living substance which have not yet attained to that dignity. We most of us speak and think of life as it occurs in ourselves and other animals with which we are familiar; and as we find it in the plants around us. We recognise it in these by the possession of certain properties—movement, nutrition, growth, and reproduction. We are not aware by intuition, nor can we ascertain without the employment of the microscope, that we and all the higher living beings, whether animal or vegetable, are entirely formed of aggregates of nucleated cells, each microscopic and each possessing its own life. Nor could we suspect by intuition that what we term our life is not a single indivisible property, capable of being blown out with a puff like the flame of a candle; but is the aggregate of the lives of many millions of living cells of which the body is composed. It is but a short while ago that this cell-constitution was discovered: it occurred within the lifetime, even within the memory, of some who are still with us. What a marvellous distance we have travelled since then in the path of knowledge of living organisms! The strides which were made in the advance of the mechanical sciences during the nineteenth century, which is generally considered to mark that century as an age of unexampled progress, are as nothing in comparison with those made in the domain of biology, and their interest is entirely dwarfed by that which is aroused by the facts relating to the phenomena of life which have accumulated within the same period. And not the least remarkable of these facts is the discovery of the cell-structure of plants and animals!

Evolution of the Cell-aggregate.

Let us consider how cell-aggregates came to be evolved from organisms consisting of single cells. Two methods are possible—viz. (1) the adhesion of a number of originally separate individuals; (2) the subdivision of a single individual without the products of its subdivision breaking loose from one another. No doubt this last is the manner whereby the cell-aggregate was originally formed, since it is that by which it is still produced, and we know that the life-history of the individual is an epitome of that of the species. Such aggregates were in the beginning solid; the cells in contact with one another and even in continuity: subsequently a space or cavity became formed in the interior of the mass, which was thus converted into a hollow sphere. All the cells of the aggregate were at first perfectly similar in structure and in function; there was no subdivision of labour. All would take part in effecting locomotion; all would receive stimuli from outside; all would take in and digest nutrient matter, which would then be passed into the cavity of the sphere to serve as a common store of nourishment. Such organisms are still found, and constitute the lowest types of Metazoa. Later one part of the hollow sphere became dimpled to form a cup; the cavity of the sphere became correspondingly altered in shape. With this change in structure, differentiation of function between the cells covering the outside and those lining the inside of the cup made its appearance. Those on the outside sub-served locomotor functions and received and transmitted from cell to cell stimuli, physical or chemical, received by the organism; while those on the inside, being freed from such functions, tended to specialise in the direction of the inception and digestion of nutrient material; which, passing from them into the cavity of the invaginated sphere, served for the nourishment of all the cells composing the organism. The further course of evolution produced many changes of form and ever-increasing complexity of the cavity thus produced by simple invagination. Some of the cell-aggregates settled down to a sedentary life, becoming plant-like in appearance and to some extent in habit. Such organisms, complex in form but simple in structure, are the Sponges. Their several parts are not, as in the higher Metazoa, closely interdependent: the destruction of any one part, however extensive, does not either immediately or ultimately involve death of the rest: all parts function separately, although doubtless mutually benefiting by their conjunction, if only by slow diffusion of nutrient fluid throughout the mass. There is already some differentiation in these organisms, but the absence of a nervous system prevents any general coordination, and the individual cells are largely independent of one another.

Our own life, like that of all the higher animals, is an *aggregate life*; the life of the whole is the life of the individual cells. The life of some of these cells can be put an end to, the rest may continue to live. This is, in fact, happening every moment of our lives. The cells which cover the surface of our body, which form the scarf-skin and the hairs and nails, are constantly dying and the dead cells are rubbed off or cut away, their place being taken by others supplied from living layers beneath. But the death of these cells does not affect the vitality of the body as a whole. They serve merely as a protection, or an ornamental covering, but are otherwise not material to our existence. On the other hand, if a few cells, such as those nerve-cells under the influence of which respiration is carried on, are destroyed or injured, within a minute or two the whole living machine comes to a standstill, so that to the bystander the patient is dead; even the doctor will pronounce life to be extinct. But this pronouncement is correct only in a special sense. What has happened is that, owing to the cessation of respiration, the supply of oxygen to the tissues is cut off. And since the manifestations of life cease without this supply, the animal or patient appears to be dead. If, however, within a short period we supply the needed oxygen to the tissues requiring it, all the manifestations of life reappear.

It is only some cells which lose their vitality at the moment of so-called "general death." Many cells of the body retain their individual life in suitable circumstances long after the rest of the body is dead. Notable among these are muscle-cells. McWilliam showed that the muscle-cells of the blood-vessels give indications of life several days after an animal has been killed. The muscle-cells of the heart in mammals have been revived and caused to beat regularly and strongly many hours after apparent death. In man this result has been obtained by Kuliabko as many as eighteen hours after life had been pronounced extinct; in animals after days had elapsed. Waller has shown that indications of life can be elicited from various tissues many hours and even days after general death. Sherrington observed the white corpuscles of the blood to be active when kept in a suitable nutrient fluid weeks after removal from the blood-vessels. A French histologist, Jolly, has found that the white corpuscles of the frog, if kept in a cool place and under suitable conditions, show at the end of a year all the ordinary manifestations of life. Carrell and Burrows have observed activity and growth to continue for long periods in the isolated cells of a number of tissues and organs kept under observation in a suitable medium. Carrell has succeeded in substituting entire organs obtained after death from one animal for those of another of the same species, and has thereby opened up a field of surgical treatment the limit of which cannot yet be descried. It is a well-established fact that any part of the body can be maintained alive for hours isolated from the rest if the blood-vessels are perfused with an oxygenated solution of salts in certain proportions (Ringer). Such revival and prolongation of the life of separated organs is an ordinary procedure in laboratories of physiology. Like all the other instances enumerated, it is based on the fact that the individual cells of an organ have a life of their own which is largely independent, so that they will continue in suitable circumstances to live, although the rest of the body to which they belonged may be dead.

But some cells, and the organs which are formed of them, are more necessary to maintain the life of the aggregate than others, on account of the nature of the functions which have become specialised in them. This is the case with the nerve-cells of the respiratory centre, since they preside over the movements which are necessary to effect oxygenation of the blood. It is also true for the cells which compose the heart, since this serves to pump oxygenated blood to all other cells of the body: without such blood most cells soon cease to live. Hence we examine respiration and heart to determine if life is present: when one or both of these are at a standstill we know that life cannot be maintained. These are not the only organs necessary for the maintenance of life, but the loss of others can be borne longer, since the functions which they subserve, although useful or even essential to the organism, can be dispensed with for a time. The life of some cells is therefore more, of others less, necessary, for maintaining the life of the rest. On the other hand, the cells composing certain organs have in the course of evolution ceased to be necessary, and their continued existence may even be harmful. Wiedersheim has enumerated more than a hundred of these organs in the human body. Doubtless Nature is doing her best to get rid of them for us, and our descendants will some day have ceased to possess a vermiform appendix or a pharyngeal tonsil; until that epoch arrives we must rely for their removal on the more rapid methods of surgery!

The Maintenance of the Life of the Cell-aggregate in the Higher Animals.—Coordinating Mechanisms.

We have seen that in the simplest multicellular organisms, where one cell of the aggregate differs but little from another, the conditions for the maintenance of the life of the whole are nearly as simple as those for individual cells. But the life of a cell-aggregate such as composes the bodies of the higher animals is maintained not only by the conditions for the maintenance of the life of the individual cell being kept favourable, but also by the coordination of the varied activities of the cells which form the aggregate. Whereas in the lowest Metazoa all cells of the aggregate are alike in structure and function and perform and share everything in common, in higher animals (and for that matter in the higher plants also) the cells have become specialised, and each is only adapted for the performance of a particular function. Thus the cells of the gastric glands are only adapted for the secretion of gastric juice, the cells of the villi for the absorption of digested matters from the intestine, the cells of the kidney for the removal of waste products and superfluous water from the blood, those of the heart for pumping blood through the vessels. Each of these cells has its individual life and performs its individual functions. But unless there were some sort of cooperation and subordination to the needs of the body generally, there would be sometimes too little, sometimes too much gastric juice secreted; sometimes too tardy, sometimes too rapid an absorption from the intestine; sometimes too little, sometimes too much blood pumped into the arteries, and so on. As the result of such lack of cooperation the life of the whole would cease to be normal and would eventually cease to be maintained.

We have already seen what are the conditions which are favourable for the maintenance of life of the individual cell, no matter where situated. The principal condition is that it must be bathed by a nutrient fluid of suitable and constant composition. In higher animals this fluid is the lymph, which bathes the tissue elements and is itself constantly supplied with fresh nutriment and oxygen by the blood. Some tissue-cells are directly bathed by blood; and in invertebrates, in which there is no special system of lymph-vessels, all the tissues are thus nourished. All cells both take from and give to the blood, but not the same materials or to an equal extent. Some, such as the absorbing cells of the villi, almost exclusively give; others, such as the cells of the renal tubules, almost exclusively take. Nevertheless, the resultant of all the give and take throughout the body serves to maintain the composition of the blood constant in all circumstances. In this way the first condition of the maintenance of the life of the aggregate is fulfilled by insuring that the life of the individual cells composing it is kept normal.

The second essential condition for the maintenance of life of the cell-aggregate is the coordination of its parts and the due regulation of their activity, so that they may work together for the benefit of the whole. In the animal body this is effected in two ways: first, through the nervous system; and second, by the action of specific chemical substances which are formed in certain organs and carried by the blood to other parts of the body, the cells of which they excite to activity. These substances have received the general designation of "hormones" (ὁρμάω, to stir up), a term introduced by Prof. Starling. Their action, and indeed their very existence, has only been recognised of late years, although the part which they play in the physiology of animals appears to be only second in importance to that of the nervous system itself; indeed, maintenance of life may become impossible in the absence of certain of these hormones.

Part played by the Nervous System in the Maintenance of Aggregate Life.—Evolution of a Nervous System.

Before we consider the manner in which the nervous system serves to coordinate the life of the cell-aggregate, let us see how it has become evolved.

The first step in the process was taken when certain of the cells of the external layer became specially sensitive to stimuli from outside, whether caused by mechanical impressions (tactile and auditory stimuli) or impressions of light and darkness (visual stimuli) or chemical impressions. The effects of such impressions were probably at first simply communicated to adjacent cells and spread from cell to cell throughout the mass. An advance was made when the more impressionable cells threw out branching feelers amongst the other cells of the organism. Such feelers would convey the effects of stimuli with greater rapidity and directness to distant parts. They may at first have been retractile, in this respect resembling the long pseudopodia of certain Rhizopoda. When they became fixed they would be potential nerve-fibres and would represent the beginning of a nervous system. Even yet (as Ross Harrison has shown), in the course of development of nerve-fibres, each fibre makes its appearance as an amœboid cell-process which is at first retractile, but gradually grows into the position it is eventually to occupy and in which it will become fixed.

In the further course of evolution a certain number of these specialised cells of the external layer sank below the general surface, partly perhaps for protection, partly for better nutrition: they became nerve-cells. They remained connected with the surface by a prolongation which became an afferent or sensory nerve-fibre, and through its termination between the cells of the general surface continued to receive the effects of external impressions; on the other hand, they continued to transmit these impressions to other, more distant cells by their efferent prolongations. In the further course of evolution the nervous system thus laid down became differentiated into distinct *afferent, efferent,* and *intermediary* portions. Once established, such a nervous system, however simple, must dominate the organism, since it would furnish a mechanism whereby the individual cells would work together more effectually for the mutual benefit of the whole.

It is the development of the nervous system, although not proceeding in all classes along exactly the same lines, which is the most prominent feature of the evolution of the Metazoa. By and through it all impressions reaching the organism from the outside are translated into contraction or some other form of cell-activity. Its formation has been the means of causing the complete divergence of the world of animals from the world of plants, none of which possess any trace of a nervous system. Plants react, it is true, to external impressions, and these impressions produce profound changes and even comparatively rapid and energetic movements in parts distant from the point of application of the stimulus—as in the well-known instance of the sensitive plant. But the impressions are in all cases propagated directly from cell to cell—not through the agency of nerve-fibres; and in the absence of anything corresponding to a nervous system it is not possible to suppose that any plant can ever acquire the least glimmer of intelligence. In animals, on the other hand, from a slight original modification of certain cells has directly proceeded in the course of evolution the elaborate structure of the nervous system with all its varied and complex functions, which reach their culmination in the workings of the human intellect. "What a piece of work is a man! How noble in reason! How infinite in faculty! In form and moving how express and admirable! In action how like an angel! In apprehension how like a god!" But lest he be elated with his physical achievements, let him remember that they are but the result of the acquisition by a few cells in a remote ancestor of a slightly greater tendency to react to an external stimulus, so that these cells were brought into closer touch with the outer world; while, on the other hand, by extending beyond the circumscribed area to which their neighbours remained restricted, they gradually acquired a dominating influence over the rest. These dominating cells became nerve-cells; and now not only furnish the means for transmission of impressions from one part of the organism to another, but in the progress of time have become the seat of perception and conscious sensation, of the formation and association of ideas, of memory, volition, and all the manifestations of the mind!

Regulation of Movements by the Nervous System.—Voluntary Movements.

The most conspicuous part played by the nervous system in the phenomena of life is that which produces and regulates the general movements of the body—movements brought about by the so-called voluntary muscles. These movements are actually the result of impressions imparted to sensory or afferent nerves at the periphery, *e.g.* in the skin or in the several organs of special sense; the effect of these impressions may not be immediate, but can be stored for an indefinite time in certain cells of the nervous system. The regulation of movements—whether they occur instantly after reception of the peripheral impression or result after a certain lapse of time; whether they are accompanied by conscious sensation or are of a purely reflex and unconscious character—is an intricate process, and the conditions of their co-ordination are of a complex nature involving not merely the causation of contraction of certain muscles, but also the prevention of contraction of others. For our present knowledge of these conditions we are largely indebted to the researches of Prof. Sherrington.

Involuntary Movements.

A less conspicuous but no less important part played by the nervous system is that by which the contractions of involuntary muscles are regulated. In normal circumstances these are always independent of consciousness, but their regulation is brought about in much the same way as is that of the contractions of voluntary muscles—viz., as the result of impressions received at the periphery. These are transmitted by afferent fibres to the central nervous system, and from the latter other impulses are sent down, mostly along the nerves of the sympathetic or autonomic system of nerves, which either stimulate or prevent contraction of the involuntary muscles. Many involuntary muscles have a natural tendency to continuous or rhythmic contraction which is quite independent of the central nervous system; in this case the effect of impulses received from the latter is merely to increase or diminish the amount of such contraction. An example of this double effect is observed in connection with the heart, which—although it can contract regularly and rhythmically when cut off from the nervous system and even if removed from the body—is normally stimulated to increased activity by impulses coming from the central nervous system through the sympathetic, or to diminished activity by others coming through the vagus. It is due to the readiness by which the action of the heart is influenced in these opposite ways by the spread of impulses generated during the nerve-storms which we term "emotions" that in the language of poetry, and even of every day, the word "heart" has become synonymous with the emotions themselves.

Effects of Emotions.

The involuntary muscle of the arteries has its action similarly balanced. When its contraction is increased, the size of the vessels is lessened and they deliver less blood; the parts they supply accordingly become pale in colour. On the other hand, when the contraction is diminished the vessels enlarge and deliver more blood; the parts which they supply become correspondingly ruddy. These changes in the arteries, like the effects upon the heart, may also be produced under the influence of emotions. Thus "blushing" is a purely physiological phenomenon due to diminished action of the muscular tissue of the arteries, whilst the pallor produced by fright is caused by an increased contraction of that tissue. Apart, however, from these conspicuous effects, there is constantly proceeding a less apparent but not less important balancing action between the two sets of nerve-fibres distributed to heart and blood-vessels; which are influenced in one direction or another by every sensation which we experience and even by impressions of which we may be wholly unconscious, such as those which occur during sleep or anaesthesia, or which affect our otherwise insensitive internal organs.

Regulation of Secretion by the Nervous System.

A further instance of nerve-regulation is seen in secreting glands. Not all glands are thus regulated, at least not directly; but in those which are, the effects are striking. Their regulation is of the same general nature as that exercised upon involuntary muscle, but it influences the chemical activities of the gland-cells and the outpouring of secretion from them. By means of this regulation a secretion can be produced or arrested, increased or diminished. As with muscle, a suitable balance is in this way maintained, and the activity of the glands is adapted to the requirements of the organism. Most of the digestive glands are thus influenced, as are the skin-glands which secrete sweat.

Regulation of Body Temperature.

And by the action of the nervous system upon the skin-glands, together with its effect in increasing or diminishing the blood-supply to the cutaneous blood-vessels, the temperature of our blood is regulated and is kept at the point best suited for maintenance of the life and activity of the tissues.

Effects of Emotions on Secretion.

The action of the nervous system upon the secretion of glands is strikingly exemplified, as in the case of its action upon the heart and blood-vessels by the effects of the emotions. Thus an emotion of one kind—such as the anticipation of food—will cause saliva to flow—"the mouth to water"; whereas an emotion of another kind—such as fear or anxiety—will stop the secretion, causing the "tongue to cleave unto the roof of the mouth," and rendering speech difficult or impossible. Such arrest of the salivary secretion also makes the swallowing of dry food difficult: advantage of this fact is taken in the "ordeal by rice" which used to be employed in the East for the detection of criminals.

Regulation by Chemical Agents: Hormones.—Internal Secretions.

The activities of the cells constituting our bodies are controlled, as already mentioned, in another way than through the nervous system, viz., by chemical agents (hormones) circulating in the blood. Many of these are produced by special glandular organs, known as internally secreting glands. The ordinary secreting glands pour their secretions on the exterior of the body or on a surface communicating with the exterior; the internally secreting glands pass the materials which they produce directly into the blood. In this fluid the hormones are carried to distant organs. Their influence upon an organ may be essential to the proper performance of its functions or may be merely ancillary to it. In the former case removal of the internally secreting gland which produces the hormone, or its destruction by disease, may prove fatal to the organism.

Suprarenals.

This is the case with the suprarenal capsules: small glands which are adjacent to the kidneys, although having no physiological connection with these organs. A Guy's physician, Dr. Addison, in the middle of the last century showed that a certain affection, almost always fatal, since known by his name, is associated with disease of the suprarenal capsules. A short time after this observation a French physiologist, Brown-Séquard, found that animals from which the suprarenal capsules are removed rarely survive the operation for more than a few days. In the concluding decade of the last century interest in these bodies was revived by the discovery that they are constantly yielding to the blood a chemical agent (or hormone) which stimulates the contractions of the heart and arteries and assists in the promotion of every action which is brought about through the sympathetic nervous system (Langley). In this manner the importance of their integrity has been explained, although we have still much to learn regarding their functions.

Thyroid.

Another instance of an internally secreting gland which is essential to life, or at least to its maintenance in a normal condition, is the thyroid. The association of imperfect development or disease of the thyroid with disorders of nutrition and inactivity of the nervous system is well ascertained. The form of idiocy known as cretinism and the affection termed myxœdema are both associated with deficiency of its secretion: somewhat similar conditions to these are produced by the surgical removal of the gland. The symptoms are alleviated or cured by the administration of its juice. On the other hand, enlargement of the thyroid, accompanied by increase of its secretion, produces symptoms of nervous excitation, and similar symptoms are caused by excessive administration of glandular substance by the mouth. From these observations it is inferred that the juice contains hormones which help to regulate the nutrition of the body and serve to stimulate the nervous system, for the higher functions of which they appear to be essential. To quote M. Gley, to whose researches we owe much of our knowledge regarding the functions of this organ: "La genèse et l'exercice des plus hautes facultés de l'homme sont conditionnés par l'action purement chimique d'un produit de sécrétion. Que les psychologues méditent ces faits!"

Parathyroids.

The case of the parathyroid glandules is still more remarkable. These organs were discovered by Sandström in 1880. They are four minute bodies, each no larger than a pin's head, imbedded in the thyroid. Small as they are, their internal secretion possesses hormones which exert a powerful influence upon the nervous system. If they are completely removed, a complex of symptoms, technically known as "tetany," is liable to occur, which is always serious and may be fatal. Like the hormones of the thyroid itself, therefore, those of the parathyroids produce effects upon the nervous system, to which they are carried by the blood; although the effects are of a different kind.

Pituitary.

Another internally secreting gland which has evoked considerable interest during the last few years is the pituitary body. This is a small structure no larger than a cob-nut attached to the base of the brain. It is mainly composed of glandular cells. Its removal has been found (by most observers) to be fatal—often within two or three days. Its hypertrophy, when occurring during the general growth of the body, is attended by an undue development of the skeleton, so that the stature tends to assume gigantic proportions. When the hypertrophy occurs after growth is completed, the extremities—viz., the hands and feet, and the bones of the face—are mainly affected; hence the condition has been termed "acromegaly" (enlargement of extremities). The association of this condition with affections of the pituitary was pointed out in 1885 by a distinguished French physician, Dr. Pierre Marie. Both "giants" and "acromegalists" are almost invariably found to have an enlarged pituitary. The enlargement is generally confined to one part—the anterior lobe—and we conclude that this produces hormones which stimulate the growth of the body generally and of the skeleton in particular. The remainder of the pituitary is different in structure from the anterior lobe and has a different function. From it hormones can be extracted which, like those of the suprarenal capsule, although not exactly in the same manner, influence the contraction of the heart and arteries. Its extracts are also instrumental in promoting the secretion of certain glands. When injected into the blood they cause a free secretion of water from the kidneys and of milk from the mammary glands, neither of which organs are directly influenced (as most other glands are) through the nervous system. Doubtless under natural conditions these organs are stimulated to activity by hormones which are produced in the pituitary and which pass from this into the blood.

The internally secreting glands which have been mentioned (thyroid, parathyroid, suprarenal, pituitary) have, so far as is known, no other function than that of producing chemical substances of this character for the influencing of other organs, to which they are conveyed by the blood. It is interesting to observe that these glands are all of very small size, none being larger than a walnut, and some—the parathyroids—almost microscopic. In spite of this, they are essential to the proper maintenance of the life of the body, and the total removal of any of them by disease or operation is in most cases speedily fatal.

Pancreas.

There are, however, organs in the body yielding internal secretions to the blood in the shape of hormones, but exercising at the same time other functions. A striking instance is furnished by the pancreas, the secretion of which is the most important of the digestive juices. This—the pancreatic juice—forms the external secretion of the gland, and is poured into the intestine, where its action upon the food as it passes out from the stomach has long been recognised. It was, however, discovered in 1889 by von Mering and Minkowski that the pancreas also furnishes an internal secretion, containing a hormone which is passed from the pancreas into the blood, by which it is carried first to the liver and afterwards to the body generally. This hormone is essential to the proper utilisation of carbohydrates in the organism. It is well known that the carbohydrates of the food are converted into grape sugar and circulate in this form in the blood, which always contains a certain amount; the blood conveys it to all the cells of the body, and they utilise it as fuel. If, owing to disease of the pancreas or as the result of its removal by surgical procedure, its internal secretion is not available, sugar is no longer properly utilised by the cells of the body and tends to accumulate in the blood; from the blood the excess passes off by the kidneys, producing diabetes.

Duodenum.

Another instance of an internal secretion furnished by an organ which is devoted largely to other functions is the "pro-secretin" found in the cells lining the duodenum. When the acid gastric juice comes into contact with these cells it converts their prosecretin into "secretin." This is a hormone which is passed into the blood and circulates with that fluid. It has a specific effect on the externally secreting cells of the pancreas, and causes the rapid outpouring of pancreatic juice into the intestine. This effect is similar to that of the hormones of the pituitary body upon the cells of the kidney and mammary gland. It was discovered by Bayliss and Starling.

Internal Secretions of the Reproductive Organs.

The reproductive glands furnish in many respects the most interesting example of organs which besides their ordinary products, the germ- and spermcells (ova and spermatozoa)—form hormones which circulate in the blood and effect changes in cells of distant parts of the body. It is through these hormones that the secondary sexual characters, such as the comb and tail of the cock, the mane of the lion, the horns of the stag, the beard and enlarged larynx of a man, are produced, as well as the many differences in form and structure of the body which are characteristic of the sexes. The dependence of these so-called secondary sexual characters upon the state of development of the reproductive organs has been recognised from time immemorial, but has usually been ascribed to influences produced through the nervous system, and it is only in recent years that the changes have been shown to be brought about by the agency of internal secretions and hormones, passed from the reproductive glands into the circulating blood.[26]

Chemical Nature of Hormones.

It has been possible in only one or two instances to prepare and isolate the hormones of the internal secretions in a sufficient condition of purity to subject them to analysis, but enough is known about them to indicate that they are organic bodies of a not very complex nature, far simpler than proteins and even than enzymes. Those which have been studied are all dialysable, are readily soluble in water but insoluble in alcohol, and are not destroyed by boiling. One at least—that of the medulla of the suprarenal capsule—has been prepared synthetically, and when their exact chemical nature has been somewhat better elucidated it will probably not be difficult to obtain others in the same way.

From the above it is clear that not only is a coordination through the nervous system necessary in order that life shall be maintained in a normal condition, but a chemical coordination is no less essential. These may be independent of one another; but, on the other hand, they may react upon one another. For it can be shown that the production of some at least of the hormones is under the influence of the nervous system (Biedl, Asher, Elliott); whilst, as we have seen, some of the functions of the nervous system are dependent upon hormones.

Protective Chemical Mechanisms.—Toxins and Antitoxins.

Time will not permit me to refer in any but the briefest manner to the protective mechanisms which the cell-aggregate has evolved for its defence against disease, especially disease produced by parasitic micro-organisms. These, which belong with few exceptions to the Protista, are without doubt the most formidable enemies which the multicellular Metazoa, to which all the higher animal organisms belong, have to contend against. To such micro-organisms are due, *inter alia*, all diseases which are liable to become epidemic, such as anthrax and rinderpest in cattle, distemper in dogs and cats, smallpox, scarlet fever, measles, and sleeping sickness in man. The advances of modern medicine have shown that the symptoms of these diseases—the disturbances of nutrition, the temperature, the lassitude or excitement, and other nervous disturbances—are the effects of chemical poisons (*toxins*) produced by the micro-organisms and acting deleteriously upon the tissues of the body. The tissues, on the other hand, endeavour to counteract these effects by producing other chemical substances destructive to the micro-organisms or antagonistic to their action: these are known as *anti-bodies*. Sometimes the protection takes the form of a subtle alteration in the living substance of the cells which renders them for a long time, or even permanently, insusceptible (immune) to the action of the poison. Sometimes certain cells of the body, such as the white corpuscles of the blood, eat the invading micro-organisms and destroy them bodily by the action of chemical agents within their protoplasm. The result of an illness thus depends upon the result of the struggle between these opposing forces—the micro-organisms on the one hand and the cells of the body on the other—both of which fight with chemical weapons. If the cells of the body do not succeed in destroying the invading organisms, it is certain that the invaders will in the long run destroy them, for in this combat no quarter is given. Fortunately we have been able, by the aid of animal experimentation, to acquire some knowledge of the manner in which we are attacked by micro-organisms and of the methods which the cells of our body adopt to repel the attack, and the knowledge is now extensively utilised to assist our defence.

Parasitic Nature of Diseases.

For this purpose protective serums or antitoxins, which have been formed in the blood of other animals, are employed to supplement the action of those which our own cells produce. It is not too much to assert that the knowledge of the parasitic origin of so many diseases and of the chemical agents which on the one hand cause, and on the other combat, their symptoms, has transformed medicine from a mere art practised empirically into a real science based upon experiment. The transformation has opened out an illimitable vista of possibilities in the direction not only of cure, but, more important still, of prevention. It has taken place within the memory of most of us who are here present. And only last February the world was mourning the death of one of the greatest of its benefactors—a former President of this Association[27]—who, by applying this knowledge to the practice of surgery, was instrumental, even in his own lifetime, in saving more lives than were destroyed in all the bloody wars of the nineteenth century!

Senescence and Death.

The question has been debated whether, if all accidental modes of destruction of the life of the cell could be eliminated, there would remain a possibility of individual cell life, and even of aggregate cell life, continuing indefinitely; in other words, Are the phenomena of senescence and death a natural and necessary sequence to the existence of life? To most of my audience it will appear that the subject is not open to debate. But some physiologists (*e.g.* Metchnikoff) hold that the condition of senescence is itself abnormal; that old age is a form of disease or is due to disease, and, theoretically at least, is capable of being eliminated. We have already seen that individual cell life, such as that of the white blood-corpuscles and of the cells of many tissues, can under suitable conditions be prolonged for days or weeks or months after general death. Unicellular organisms kept under suitable conditions of nutrition have been observed to carry on their functions normally for prolonged periods and to show no degeneration such as would accompany senescence. They give rise by division to others of the same kind, which also, under favourable conditions, continue to live, to all appearance indefinitely. But these instances, although they indicate that in the simplest forms of organisation existence may be greatly extended without signs of decay, do not furnish conclusive evidence of indefinite

[26] The evidence is to be found in F. H. A. Marshall, "The Physiology of Reproduction," 1911.

[27] Lord Lister was President at Liverpool in 1896.

prolongation of life. Most of the cells which constitute the body, after a period of growth and activity, sometimes more, sometimes less prolonged, eventually undergo atrophy and cease to perform satisfactorily the functions which are allotted to them. And when we consider the body as a whole, we find that in every case the life of the aggregate consists of a definite cycle of changes which, after passing through the stages of growth and maturity, always leads to senescence, and finally terminates in death. The only exception is in the reproductive cells, in which the processes of maturation and fertilisation result in rejuvenescence, so that instead of the usual downward change towards senescence, the fertilised ovum obtains a new lease of life, which is carried on into the new-formed organism. The latter again itself ultimately forms reproductive cells, and thus the life of the species is continued. It is only in the sense of its propagation in this way from one generation to another that we can speak of the indefinite continuance of life: we can only be immortal through our descendants!

Average Duration of Life and Possibility of its Prolongation.

The individuals of every species of animal appear to have an average duration of existence.[28] Some species are known the individuals of which live only for a few hours, whilst others survive for a hundred years.[29] In man himself the average length of life would probably be greater than the three-score and ten years allotted to him by the Psalmist if we could eliminate the results of disease and accident; when these results are included it falls far short of that period. If the terms of life given in the purely mythological part of the Old Testament were credible, man would in the early stages of his history have possessed a remarkable power of resisting age and disease. But, although many here present were brought up to believe in their literal veracity, such records are no longer accepted even by the most orthodox of theologians, and the nine hundred odd years with which Adam and his immediate descendants are credited, culminating in the nine hundred and sixty-nine of Methuselah, have been relegated, with the accounted of Creation and the Deluge, to their proper position in literature. When we come to the Hebrew patriarchs, we notice a considerable diminution to have taken place in what the insurance offices term the "expectation of life." Abraham is described as having lived only to 175 years, Joseph and Joshua to 110, Moses to 120; even at that age "his eye was not dim nor his natural force abated." We cannot say that under ideal conditions all these terms are impossible; indeed, Metchnikoff is disposed to regard them as probable; for great ages are still occasionally recorded, although it is doubtful if any as considerable as these are ever substantiated. That the expectation of life was better then than now would be inferred from the apologetic tone adopted by Jacob when questioned by Pharaoh as to his age: "The days of the years of my pilgrimage are a hundred and thirty years; few and evil have the days of the years of my life been, and have not attained unto the days of the years of the life of my fathers in the days of their pilgrimage." David, to whom, before the advent of the modern statistician, we owe the idea that seventy years is to be regarded as the normal period of life,[30] is himself merely stated to have "died in a good old age." The periods recorded for the Kings show a considerable falling-off as compared with the Patriarchs; but not a few were cut off by violent deaths, and many lived lives which were not ideal. Amongst eminent Greeks and Romans few very long lives are recorded, and the same is true of historical persons in mediæval and modern history. It is a long life that lasts much beyond eighty; three such linked together carry us far back into history. Mankind is in this respect more favoured than most mammals, although a few of these surpass the period of man's existence.[31] Strange that the brevity of human life should be a favourite theme of preacher and poet when the actual term of his "erring pilgrimage" is greater than that of most of his fellow creatures!

The End of Life.

The modern applications of the principles of preventive medicine and hygiene are no doubt operating to lengthen the average life. But even if the ravages of disease could be altogether eliminated, it is certain that at any rate the fixed cells of our body must eventually grow old and ultimately cease to function; when this happens to cells which are essential to the life of the organism, general death must result. This will always remain the universal law, from which there is no escape. "All that lives must die, passing through nature to eternity."

Such natural death unaccelerated by disease—is not death by disease as unnatural as death by accident?—should be a quiet, painless phenomenon, unattended by violent change. As Dastre expresses it, "The need of death should appear at the end of life, just as the need of sleep appears at the end of the day." The change has been led gradually up to by an orderly succession of phases, and is itself the last manifestation of life. Were we all certain of a quiet passing—were we sure that there would be "no moaning of the bar when we go out to sea"—we could anticipate the coming of death after a ripe old age without apprehension. And if ever the time shall arrive when man will have learned to regard this change as a simple physiological process, as natural as the oncoming of sleep, the approach of the fatal shears will be as generally welcomed as it is now abhorred. Such a day is still distant; we can scarcely say that its dawning is visible. Let us at least hope that, in the manner depicted by Dürer in his well-known etching, the sunshine which science irradiates may eventually put to flight the melancholy which hovers, bat-like, over the termination of our lives, and which even the anticipation of a future happier existence has not hitherto succeeded in dispersing.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. H. L. CALLENDAR, LL.D., F.R.S., PRESIDENT OF THE SECTION.

My first duty on taking the chair is to say a few words in commemoration of the distinguished members whom we have lost since the last meeting.

George Chrystal, Professor of Mathematics in the University of Edinburgh for more than thirty years, officiated as President of this section in the year 1885, and took a prominent part in the advancement of science as secretary of the Royal Society of Edinburgh since 1901. Of his brilliant mathematical work and his ability in developing the school at Edinburgh, I am not competent to speak, but I well remember as a student his admirable article on "Electricity and

28 This was regarded by Buffon as related to the period of growth, but the ratio is certainly not constant. The subject is discussed by Ray Lankester in an early work: "On Comparative Longevity in Man and Animals," 1870.

29 The approximate regular periods of longevity of different species of animals furnishes a strong argument against the theory that the decay of old age is an accidental phenomenon, comparable with disease.

30 The expectation of life of a healthy man of fifty is still reckoned at about twenty years.

31 "Hominis ævum cæterorum animalium omnium superat præter admodum paucorum."—Francis Bacon, "Historia vitæ et mortis," 1637.

Magnetism contributed to the "Encyclopaedia Britannica," which formed at that time the groundwork of our studies at Cambridge under Sir J. J. Thomson. It would be difficult to find a more complete and concise statement of the mathematical theory at the time when that article was written. One can well understand the value of such a teacher, and sympathise with his university in the loss they have sustained.

John Brown, F.R.S., who acted as local secretary for the Association at Belfast in 1902, will be remembered for his work on the Volta contact effect between metals, which he showed to be in the main dependent on chemical action, and to be profoundly affected by the nature of the gas or other medium in which the plates were immersed. Although the theory of this difficult subject may not yet be completely elucidated, there can be little doubt that his work takes the first rank on the experimental side.

William Sutherland, D.Sc., who at one time acted as Professor of Physics at Melbourne, is best known for his familiar papers on the subject of molecular physics in *The Philosophical Magazine*. His work was always remarkable for its wide range and boldness of imagination. Many of his hypotheses cannot yet be weighed in the balance of experiment, but some have already been substantiated. For instance, his theory of the variation of viscosity of gases with temperature has been generally accepted, and results are now commonly expressed in terms of Sutherland's constant.

Osborne Reynolds, the first Professor of Engineering at Owens College, was President of Section G in 1887, but belongs almost as much to mathematics and physics, in which his achievements are equally memorable. It would be scarcely possible for me to enumerate his important contributions to the science of engineering, which will be more fittingly commemorated elsewhere. His mastery of mathematical and physical methods, while contributing greatly to his success as a pioneer in the engineering laboratory, enabled him to attack the most difficult problems in physics, such as the theory of the radiometer and the thermal transpiration of gases. His determination of the mechanical equivalent of heat is a most striking example of accurate physical measurement carried out on an engineering scale. His last great work, on the "Submechanics of the Universe," is so original in its ideas and methods that its value cannot yet be fully appreciated. While it differs so radically from our preconceived ideas that it fails to carry immediate conviction, it undoubtedly represents possibilities of truth which subsequent workers in the same field cannot afford to ignore.

The present year has been one of remarkable activity in the world of mathematical and physical science if we may measure activity by the number and importance of scientific gatherings like the present for the interchange of ideas and the general advancement of science. The celebration of the 250th anniversary of the foundation of the Royal Society brought to our shores a number of distinguished delegates from all parts of the world, to promote the ever-growing fellowship among men of science which is one of the surest guarantees of international progress. The Congress of Universities of the Empire brought other guests from distant British dominions, and considered, as one of the principal points in its programme, the provision of facilities for the interchange of students between different universities, which will doubtless prove particularly advantageous to the scientific student in the higher branches of research. In the special branches of knowledge more particularly associated with this section, the International Congress of Mathematics at Cambridge, while it affords to Cambridge men like myself a most gratifying recognition of our *alma mater* as one of the leading schools of mathematics in the world, has given us the opportunity of meeting here a number of distinguished foreign mathematicians whose presence and personality cannot be otherwise than inspiring to our proceedings, and will compensate for any deficiency in our own mathematical programme. The Optical Convention held this year in London, by the importance of the papers contributed for discussion, and by its admirable exhibition of British instruments, has revealed the extent of our optical industry and talent, and has done much to dispel the impression, fostered by an unfortunate trade regulation, that the majority of optical instruments were "made elsewhere." The Radio-Telegraphic Conference, held under the auspices of the British Government, has formulated recommendations for regulating and extending the application of the discoveries of modern physics for saving life and property at sea. The work of this Conference will be fittingly supplemented on the scientific side by the discussion on wireless telegraphy which has been arranged to take place in this section in conjunction with Section G.

It would be impossible, even if it were not out of place, for me to attempt to review in detail the important work of these congresses, a full account of which will shortly be available in their several reports of proceedings now in course of publication. In the present age of specialisation and rapid publication it would be equally impossible to give any connected account in the time at my disposal of recent developments in those branches of science which come within the range of our section. The appropriate alternative, adopted by the majority of my predecessors in this chair, is to select some theory or idea, sufficiently fundamental to be of general interest, and to discuss it in the light of recent experimental evidence. It may sometimes be advantageous to take stock of our fundamental notions in this way, and to endeavour to determine how far they rest on direct experiment, and how far they are merely developments of some dynamical analogy, which may represent the results of experiment up to a certain point, but may lead to erroneous conclusions if pushed too far. With this object I propose to consider on the present occasion some of our fundamental ideas with regard to the nature of heat, and in particular to suggest that we might with advantage import into our modern theory some of the ideas of the old caloric or material theory which has for so long a time been forgotten and discredited. In so doing I may appear to many of you to be taking a retrograde step, because the caloric theory is generally represented as being fundamentally opposed to the kinetic theory and to the law of the conservation of energy. I would, therefore, remark at the outset that this is not necessarily the case, provided that the theory is rightly interpreted and applied in accordance with experiment. Mistakes have been made on both theories, but the method commonly adopted of selecting all the mistakes made in the application of the caloric theory and contrasting them with the correct deductions from the kinetic theory has created an erroneous impression that there is something fundamentally wrong about the caloric theory, and that it is in the nature of things incapable of correctly representing the facts. I shall endeavour to show that this fictitious antagonism between the two theories is without real foundation. They should rather be regarded as different ways of describing the same phenomena. Neither is complete without the other. The kinetic theory is generally preferable for elementary exposition, and has come to be almost exclusively adopted for this purpose; but in many cases the caloric theory would have the advantage of emphasising at the outset the importance of fundamental facts which are too often obscured in the prevailing method of treatment.

The explanation of the development of heat by friction was one of the earliest difficulties encountered by the caloric theory. One explanation, maintained by Cavendish and others, was simply that caloric was generated *de novo* by friction in much the same way as electricity. Another explanation, more commonly adopted, was that the fragments of solid, abraded in such operations as boring cannon, had a smaller capacity for heat than the original material. Caloric already existing in the substance was regarded as being squeezed or ground out of it without any fresh caloric being actually generated. The probability of the second explanation was negatived by the celebrated experiments of Rumford and Davy, who concluded that friction did not diminish the capacities of bodies for heat, and that it could not be a material substance because the supply obtainable by friction appeared to be inexhaustible. Rumford also showed that no increase of weight in a body when heated could be detected by the most delicate apparatus available in his time. Caloric evidently did not possess to any marked extent the properties of an ordinary ponderable fluid; but, if it had any real existence and was not merely a convenient mathematical fiction, it must be something of the same nature as the electric fluids, which had already played so useful a part in the description of phenomena, although their actual existence as physical entities had not then been demonstrated. Heat, as Rumford and Davy maintained, might be merely a mode of motion or a vibration of the ultimate particles of matter, but the idea in this form was too vague to serve as a basis of measurement or calculation. The simple conception of caloric, as a measurable quantity of something, sufficed for many purposes, and led in the hands of Laplace and others to correct results for the ratio of the specific heats, the adiabatic equation of gases, and other fundamental points of theory, though many problems in the relations of heat and work remained obscure.

The greatest contribution of the caloric theory to thermodynamics was the production of Carnot's immortal "Reflections on the Motive Power of Heat." It is one of the most remarkable illustrations of the undeserved discredit into which the caloric theory has fallen, that this work, the very foundation of modern thermodynamics, should still be misrepresented, and its logic assailed, on the ground that much of the reasoning is expressed in the language of the caloric theory. In justice to Carnot, even at the risk of wearying you with an oft-told tale, I cannot refrain from taking this opportunity of reviewing the essential points of his reasoning, because it affords incidentally the best introduction to the conception of caloric, and explains how a quantity of caloric is to be measured.

At the time when Carnot wrote, the industrial importance of the steam-engine was already established, and the economy gained by expansive working was generally appreciated. The air-engine, and a primitive form of the internal-combustion engine, had recently been invented. On account of the high value of the latent heat of steam, it was confidently expected that more work might be obtained from a given quantity of heat or fuel by employing some other working substance, such as alcohol or ether, in place of steam. Carnot set himself to investigate the conditions under which motive-power was obtainable from heat, how the efficiency was limited, and whether other agents were preferable to steam. These were questions of immediate practical importance to the engineer, but the answer which Carnot found embraces the whole range of science in its ever-widening scope.

In discussing the production of work from heat it is necessary, as Carnot points out, to consider a complete series or cycle of operations in which the working substance, and all parts of the engine, are restored on completion of the cycle to their initial state. Nothing but heat, or its equivalent fuel, may be supplied to the engine. Otherwise part of the motive power obtained might be due, not to heat alone, but to some change in the working substance, or in the disposition of the mechanism. Carnot here assumes the fundamental axiom of the cycle, which he states as follows:—"*When a body has undergone any changes, and, after a certain number of transformations, it is brought back identically to its original state, considered relatively to density, temperature, and mode of aggregation, it must contain the same quantity of heat as it contained originally.*" This does not limit the practical application of the theory, because all machines repeat a regular series of operations, which may be reduced in theory to an equivalent cycle in which everything is restored to its initial state.

The most essential feature of the working of all heat-engines, considered apart from details of mechanism, is the production of motive power by alternate expansion or contraction, or heating and cooling of the working substance. This necessitates the existence of a difference of temperature, produced by combustion or otherwise, between two bodies, such as the boiler and condenser of a steam-engine, which may be regarded as the source and sink of heat respectively. Wherever a difference of temperature exists, it may be made a source of motive-power, and conversely, without difference of temperature, no motive-power can be obtained from heat by a cyclical or continuous process. From this consideration Carnot deduces the simple and sufficient rule for obtaining the maximum effect:—"*In order to realise the maximum effect, it is necessary that, in the process employed, there should not be any direct interchange of heat between bodies at sensibly different temperatures.*" Direct transference of heat between bodies at sensibly different temperatures would be equivalent to wasting a difference of temperature which might have been utilised for the production of motive-power. Equality of temperature is here assumed as the limiting condition of thermal equilibrium, such that an infinitesimal difference of temperature will suffice to determine the flow of heat in either direction. An engine satisfying Carnot's rule will be reversible so far as the thermal operations are concerned. Carnot makes use of this property of reversibility in deducing his formal proof that an engine of this type possesses the maximum efficiency. If in the usual or direct method of working such an engine takes a quantity of heat Q from the source, rejects heat to the condenser, and gives a balance of useful work W per cycle, when the engine is reversed and supplied with motive-power W per cycle it will in the limit take the same quantity of heat from the condenser as it previously rejected, and return to the source the same quantity of heat Q as it took from it when working direct. All such engines must have the same efficiency (measured by the ratio W/Q of the work done to the heat taken from the source) whatever the working substance, provided that they work between the same temperature limits. For, if this were not the case, it would be theoretically possible, by employing the most efficient to drive the least efficient reversible engine backwards, to restore to the source all the heat taken from it, and to obtain a balance of useful work without the consumption of fuel; a result sufficiently improbable to serve as the basis of a formal proof. Carnot thus deduces his famous principle, which he states as follows:—"*The motive power obtainable from heat is independent of the agents set at work to realise it. Its quantity is fixed* *solely by the temperatures between which in the limit the transfer of heat takes place.*"

Objection is commonly taken to Carnot's proof, on the ground that the combination which he imagines might produce a balance of useful work without infringing the principle of conservation of energy, or constituting what we now understand as perpetual motion of the ordinary kind in mechanics. It has become the fashion to introduce the conservation of energy in the course of the proof, and to make a final appeal to some additional axiom. Any proof of this kind must always be to some extent a matter of taste; but since Carnot's principle cannot be deduced from the conservation of energy alone, it seems a pity to complicate the proof by appealing to it. For the particular object in view, the absurdity of a heat-engine working without fuel appears to afford the most appropriate improbability which could be invoked. The final appeal must be to experiment in any case. At the present time the experimental verification of Carnot's principle in its widest application so far outweighs the validity of any deductive proof, that we might well rest content with the logic that satisfied Carnot instead of confusing the issue by disputing his reasoning.

Carnot himself proceeded to test his principle in every possible way by comparison with experiment so far as the scanty data available in his time would permit. He also made several important deductions from it, which were contrary to received opinion at the time, but have since been accurately verified. He appears to have worked out these results analytically in the first instance, as indicated by his footnotes, and to have translated his equations into words in the text for the benefit of his non-mathematical readers. In consequence of this, some of his most important conclusions appear to have been overlooked or attributed to others. Owing to want of exact knowledge of the properties of substances over extended ranges of temperature, he was unable to apply his principle directly in the general form for any temperature limits. We still labour to a less extent under the same disability at the present day. He showed, however, that a great simplification was effected in its application by considering a cycle of infinitesimal range at any temperature t. In this simple case the principle is equivalent to the assertion that the work obtainable from a unit of heat per degree fall (or per degree range of the cycle) at a temperature t, is some function $F't$ of the temperature (generally known as Carnot's function), which must be the same for all substances at the same temperature. From the rough data then available for the properties of steam, alcohol, and air, he was able to calculate the numerical values of this function in kilogrammetres of work per kilocalorie of heat at various temperatures between 0° and 100° C., and to show that it was probably the same for different substances at the same temperature within the limits of experimental error. For the vapour of alcohol at its boiling-point, 78·7° C., he found the value $F't = 1{\cdot}230$ kilogrammetres per kilocalorie per degree fall. For steam at the same temperature he found nearly the same value, namely, $F't = 1{\cdot}212$. Thus no advantage in point of efficiency could be gained by employing the vapour of alcohol in place of steam. He was also able to show that the work obtainable from a kilocalorie per degree fall probably diminished with rise of temperature, but his data were not sufficiently exact to indicate the law of the variation.

The equation which Carnot employed in deducing the numerical values of his function from the experimental data for steam and alcohol is simply the direct expression of his principle as applied to a saturated vapour. It is now generally known as Clapeyron's equation, because Carnot did not happen to give the equation itself in algebraic form, although the principle and details of the calculation were most minutely and accurately described. In calculating the value of his function for air, Carnot made use of the known value of the difference of the specific heats at constant pressure and volume. He showed that this difference must be the same for equal volumes of all gases measured under the same temperature and pressure, whereas it had always previously been assumed that the ratio (not the difference) of the specific heats was the same for different gases. He also gave a general expression for the heat absorbed by a gas in expanding at constant temperature, and showed that it must bear a constant ratio to the work of expansion. These results were verified experimentally some years later, in part by Dulong, and more completely by Joule, but Carnot's theoretical prediction has generally been overlooked, although it was of the greatest interest and importance. The reason of this neglect is probably to be found in the fact that Carnot's expressions contained the unknown function $F't$ of the temperature, the form of which could not be deduced without making some assumptions with regard to the nature of heat and the scale on which temperature should be measured.

It was my privilege to discover a few years ago that Carnot himself had actually given the correct solution of this fundamental problem in one of his most important footnotes, where it had lain buried and unnoticed for more than eighty years. He showed by a most direct application of the caloric theory that if temperature was measured on the scale of a perfect gas (which is now universally adopted) the value of his function $F't$ on the caloric theory would be the same at all temperatures, and might be represented simply by a numerical constant A (our "mechanical equivalent") depending on the units adopted for work and heat. In other words, the work W done by a quantity of caloric Q in a Carnot cycle of range T to T_0 on the gas scale would be represented by the simple equation:

$$W = AQ(T - T_0).$$

It is at once obvious that this solution, obtained by Carnot from the caloric theory, so far from being inconsistent with the mechanical theory of heat, is a direct statement of the law of conservation of energy as applied to the Carnot cycle. If the lower limit T_0 of the cycle is taken at the absolute zero of the gas-thermometer, we observe that the maximum quantity of work obtainable from a quantity of caloric Q at a temperature T is simply AQT, which represents the absolute value of the energy carried by the caloric taken from the source at the temperature T. The energy of the caloric rejected at the temperature T_0 is AQT_0. The external work done is equal to the difference between the quantities of heat energy supplied and rejected in the cycle.

The analogy which Carnot himself employed in the interpretation of this equation was the oft-quoted analogy of the waterfall. Caloric might be regarded as possessing motive-power or energy in virtue of elevation of temperature just as water may be said to possess motive-power in virtue of its head or pressure. The limit of motive-power obtainable by a reversible motor in either case would be directly proportional to the head or fall measured on a suitable scale. Caloric itself was not motive-power, but must be regarded simply as the vehicle or carrier of energy, the production of motive-power from caloric depending essentially (as Carnot puts it) not on the actual consumption of caloric, but on the fall of temperature available. The measure of a quantity of caloric is the work done per degree fall, which corresponds with the measure of a quantity of water by weight, *i.e.* in kilogrammetres per metre fall.

That Carnot did not pursue the analogy further, and deduce the whole mechanical theory of heat from the caloric theory, is scarcely to be wondered at if we remember that no applications of the energy principle had then been made in any department of physics. He appears, indeed, at a later date to have caught a glimpse of the general principle when he states that "motive-power [his equivalent for work or energy] changes its form but is never annihilated." It is clear from the posthumous notes of his projected experimental work that he realised how much remained to be done on the experimental side, especially in relation to the generation of caloric by friction, and the waste of motive-power by conduction of heat, which appeared to him (in 1824) "almost inexplicable in the present state of the theory of heat."

One of the points which troubled him most in the application of the theoretical result that the work obtainable from a quantity of caloric was simply proportional to the fall of temperature available, was that it required that the specific heat of a perfect gas should be independent of the pressure. This was inconsistent with the general opinion prevalent at the time, and with one solitary experiment by Delaroche and Bérard, which appeared to show that the specific heat of a gas diminished with increase of pressure, and which had been explained by Laplace as a natural consequence of the caloric theory. Carnot showed that this result did not necessarily follow from the caloric theory, but the point was not finally decided in his favour until the experiments of Regnault, first published in 1852, established the correct values of the specific heat of gases, and proved that they were practically independent of the pressure.

Another point which troubled Carnot was that, according to his calculations, the motive-power obtainable from a kilocalorie of heat per degree fall appeared to diminish with rise of temperature, instead of remaining constant. This might have been due to experimental errors, since the data were most uncertain. But, if he had lived to carry out his projected experiments on the quantity of motive-power required to produce one unit of heat, and had obtained the result, 424 kilogrammetres per kilocalorie, subsequently found by Joule, he could scarcely have failed to notice that this was the same (within the limits of experimental error) as the maximum work AQT obtainable from the kilocalorie according to his equation. (This is seen to be the case when the values calculated by Carnot per degree fall at different temperatures were multiplied by the absolute temperature in each case. *E.g.* 1·212 kilogrammetres per degree fall with steam at 79° C. or 352° Abs. $1{\cdot}212 \times 352 = 426$ kilogrammetres.) The origin of the apparent discrepancy between theory and experiment lay in the tacit assumption that the quantity of caloric in a kilocalorie was the same at different temperatures. There were no experiments at that time available to demonstrate that the caloric measure of heat as work per degree fall, implied in Carnot's principle, or more explicitly stated in his equation, was not the same as the calorimetric measure obtained by mixing substances at different temperatures. Even when the energy principle was established its exponents failed to perceive exactly where the discrepancy between the two theories lay. In reality both were correct, if fairly interpreted in accordance with experiment, but they depended on different methods of measuring a quantity of heat, which, so far from being inconsistent, were mutually complementary.

The same misconception, in a more subtle and insidious form, is still prevalent in such common phrases as the following: "We now know that heat is a form of energy and not a material fluid." The experimental fact underlying this statement is that our ordinary methods of measuring quantities of heat in reality measure quantities of thermal energy. When two substances at different temperatures are mixed, the quantity remaining constant, provided that due allowance is made for external work done and for external loss of heat, is the total quantity of energy. Heat is a form of energy merely because the thing we measure and call heat is really a quantity of energy. Apart from considerations of practical convenience, we might equally well have agreed to measure a quantity of heat in accordance with Carnot's principle, by the external work done in a cycle per degree fall. Heat would then not be a form of energy, but would possess all the properties postulated for caloric. The caloric measure of heat follows directly from Carnot's principle, just as the energy measure follows from the law of conservation of energy. But the term *heat* has become so closely associated with the energy measure that it is necessary to employ a different term, *caloric*, to denote the simple measure of a quantity of heat as opposed to a quantity of heat energy. The measurement of heat as caloric is precisely analogous to the measure of electricity as a quantity of electric fluid. In the case of electricity, the quantity measure is more familiar than the energy measure, because it is generally simpler to measure electricity by its chemical and magnetic effects as a quantity of fluid than as a quantity of energy. The units for which we pay by electric meter, however, are units of energy, because the energy supplied is the chief factor in determining the cost of production, although the actual quantity of fluid supplied has a good deal to do with the cost of distribution. Both methods of measurement are just as important in the theory of heat, and it seems a great pity that the natural measure of heat quantity is obscured in the elementary stages of exposition by regarding heat simply as so much energy. The inadequacy of such treatment makes itself severely felt in the later stages.

Since Carnot's principle was adopted without material modification into the mechanical theory of heat, it was inevitable that Carnot's caloric, and his solution for the work done in a finite cycle, should sooner or later be rediscovered. Caloric reappeared first as the "thermodynamic function" of Rankine, and as the "equivalence-value of a transformation" in the equations of Clausius; but it was regarded rather as the quotient of heat energy by temperature than as possessing any special physical significance. At a later date, when its importance was more fully recognised, Clausius gave it the name of *entropy*, and established the important property that its total quantity remained constant in reversible heat exchanges, but always increased in an irreversible process. Any process involving a decrease in the total quantity of entropy was impossible. Equivalent propositions with regard to the possibility or impossibility of transformations had previously been stated by Lord Kelvin in terms of the dissipation of available energy. But, since Carnot's solution had been overlooked, no one at the time seems to have realised that entropy was simply Carnot's caloric under another name, that heat could be measured otherwise than as energy, and that the increase of entropy in any irreversible process was the most appropriate measure of the quantity of heat generated. Energy so far as we know must always be associated with something of a material nature acting as carrier, and there is no reason to believe that heat energy is an exception to this rule. The tendency of the kinetic theory has always been to regard entropy as a purely abstract mathematical function, relating to the distribution of the energy, but having no physical existence. Thus it is not a quantity of anything in the kinetic theory of gases, but merely the logarithm of the probability of an arrangement. In a similar way, some twenty years ago the view was commonly held that electric phenomena were due merely to strains in the æther, and that the electric fluids had no existence except as a convenient means of mathematical expression. Recent discoveries have enabled us to form a more concrete conception of a charge of electricity, which has proved invaluable as a guide to research. Perhaps it is not too much to hope that it may be possible to attach a similar conception with advantage to caloric as the measure of a quantity of heat.

It has generally been admitted in recent years that some independent measure of heat quantity as opposed to heat energy is required, but opinions have differed widely with regard to the adoption of entropy as the quantity factor of heat. Many of these objections have been felt rather than explicitly stated, and are therefore the more difficult to answer satisfactorily. Others arise from the difficulty of attaching any concrete conception of a quantity of something to such a vague and shadowy mathematical function as entropy. The answer to the question "What is caloric?" must necessarily be of a somewhat speculative nature. But it is so necessary for the experimentalist to reason by analogy from the seen to the unseen, that almost any answer, however crude, is better than none at all. The difficulties experienced in regarding entropy as a measure of heat quantity are more of an academic nature, but may be usefully considered as a preliminary in attempting to answer the more fundamental question.

The first difficulty felt by the student in regarding caloric as the measure of heat quantity is that when two portions of the same substance, such as water, at different temperatures are mixed, the quantity of caloric in the mixture is greater than the sum of the quantities in the separate portions. The same difficulty was encountered by Carnot from the opposite point of view. The two portions at different temperatures represented a possible source of motive-power. The question which he asked himself may be put as follows:—"If the total quantity of caloric remained the same when the two portions at different temperatures were simply mixed, what had become of the motive-power wasted?" The answer is that caloric is generated, and that the quantity generated is such that its energy is the precise equivalent of the motive-power which might have been obtained if the transfer of heat had been effected by means of a perfect engine working without generation of caloric. The caloric generated in wasting a difference of temperature is the necessary and appropriate measure of the quantity of heat obtained by the degradation of available motive-power into the less available or transformable variety of heat energy.

The processes by which caloric is generated in mixing substances at different temperatures, or in other cases where available motive-power is allowed to run to waste, are generally of so turbulent a character that the steps of the process cannot be followed, although the final result can be predicted under given conditions from the energy principle. Such processes could not be expected *a priori* to throw much light on the nature of caloric. The familiar process of conduction of heat through a body the parts of which are at different temperatures, while equally leading to the generation of a quantity of caloric equivalent to the motive-power wasted, affords better promise of elucidating the nature of caloric, owing to the comparative simplicity and regularity of the phenomena, which permit closer experimental study. The earliest measurements of the relative conducting powers of the metals for heat and electricity showed that the ratio of the thermal to the electric conductivity was nearly the same for all the pure metals, and suggested that, in this case, the carriers of heat and electricity were the same. Later and more accurate experiments showed that the ratio of the conductivities was not constant, but varied nearly as the absolute temperature. At first sight this might appear to suggest a radical difference between the two conductivities, but it results merely from the fact that heat is measured as energy in the definition of thermal conductivity, whereas electricity is measured as a quantity of fluid. If thermal conductivity were defined in terms of caloric or thermal fluid, the ratio of the two conductivities would be constant with respect to temperature almost, if not quite, within the limits of error of experiment. On the hypothesis that the carriers are the same for electricity and heat, and that the kinetic energy of each carrier is the same as that of a gas molecule at the same temperature, it becomes possible, on the analogy of the kinetic theory of gases, to calculate the actual value of the ratio of the conductivities. The value thus found agrees closely in magnitude with that given by experiment, and may be regarded as confirming the view that the carriers are the same, although the hypotheses and analogies invoked are somewhat speculative.

When the electrons or corpuscles of negative electricity were discovered it was a natural step to identify them with the carriers of energy, and to imagine that a metal contained a large number of such corpuscles, moving in all directions, and colliding with each other and with the metallic atoms, like the molecules of a gas on the kinetic theory. If the mass of each carrier were 1/1700 of that of an atom of hydrogen, the velocity at 0° C. would be about sixty miles a second, and would be of the right order of magnitude to account for the observed values of the conductivities of good conductors, on the assumption that the number of negative corpuscles was the same as the number of positive metallic atoms, and that the mean free path of each corpuscle was of the same order as the distance between the atoms. The same hypothesis served to give a qualitative account of thermo-electric phenomena, such as the Peltier and Thomson effects, and of radiation and absorption of heat, though in a less satisfactory manner. When extended to give a consistent account of *all* the related phenomena, it would appear that the number of free corpuscles required is too large to be reconciled, for instance, with the observed values of the specific heat, on the assumption that each corpuscle possesses energy of translation equal to that of a gas molecule at the same temperature.

Sir J. J. Thomson has accordingly proposed and discussed another possible theory of metallic conduction, in which the neutral electric doublets present in the metal are supposed to be continually interchanging corpuscles at a very high rate. Under ordinary condition these interchanges take place indifferently in all directions, but under the action of an electric field the axes of the doublets are supposed to become more or less oriented, as in the Grotthus-chain hypothesis of electrolytic conduction, producing a general drift or current proportional to the field. This hypothesis, though fundamentally different from the preceding or more generally accepted view, appears to lead to practically the same relations, and is in some ways preferable, as suggesting possible explanations of difficulties encountered by the first theory in postulating so large a number of free negative corpuscles. On the other hand, the second theory requires that each neutral doublet should be continually ejecting corpuscles at the rate of about 10^{15} per second. There are probably elements of truth in both theories, but, without insisting too much on the exact details of the process, we may at least assert with some confidence that the corpuscles of caloric which constitute a current of heat in a metal are very closely related to the corpuscles of electricity, and have an equal right to be regarded as constituting a material fluid possessing an objective physical existence.

If I may be allowed to speculate a little on my own account (as we are all here together in holiday mood, and you will not take anything I may say too seriously), I should prefer to regard the molecules of caloric, not as being identical with the corpuscles of negative electricity, but as being neutral doublets formed by the union of a positive and negative corpuscle, in much the same way as a molecule of hydrogen is formed by the union of two atoms. Nothing smaller than a hydrogen atom has yet, so far as I know, been discovered with a positive charge. This may be merely a consequence of the limitations of our experimental methods, which compel us to employ metals to so large an extent as electrodes. In the symmetry of nature it is almost inconceivable that the positive corpuscle should not exist, if only as the other end of the Faraday-tube or vortex-filament representing a chemical bond. Prof. Bragg has identified the X or γ rays with neutral corpuscles travelling at a high velocity, and has maintained this hypothesis with brilliant success against the older view that these rays are not separate entities, but merely thin, spreading pulses in the æther produced by the collisions of corpuscles with matter. I must leave him to summarise the evidence, but if neutral corpuscles exist, or can be generated in any way, it should certainly be much easier to detach a neutral corpuscle from a material atom or molecule than to detach a corpuscle with a negative charge from the positive atom with which it is associated. We should therefore expect neutral corpuscles to be of such exceedingly common and universal occurrence that their very existence might be overlooked, unless they happened to be travelling at such exceptionally high velocities as are associated with the γ rays. According to the pulse theory, it is assumed that all γ rays travel with the velocity of light, and that the enormous variations observed in their penetrative power depend simply on the thickness of the pulse transmitted. On the corpuscular theory, the penetrative power, like that of the α and β rays, is a question of size, velocity, and electric charge. Particles carrying electric charges, like the α and β rays, lose energy in producing ions by their electric field, perhaps without actual collision. Neutral or γ rays do not produce ions directly, but dislodge either γ rays or β rays from atoms by direct collisions, which are comparatively rare. The β rays alone, as C. T. R. Wilson's photographs show, are responsible for the ionisation. Personally, I have long been a convert to Prof. Bragg's views on the nature of X rays, but even if we regard the existence of neutral corpuscles as not yet definitely proved, it is, I think, permissible to assume their existence for purposes of argument, in order to see whether the conception may not be useful in the interpretation of physical phenomena.

If, for instance, we assume that the neutral corpuscles or molecules of caloric exist in conductors and metallic bodies in a comparatively free state of solution, and are readily dissociated into positive and negative electrons owing to the high specific inductive capacity of the medium, the whole theory of metallic conduction follows directly on the analogy of conduction in electrolytic solutions. But, whereas in electrolytes the ions are material atoms moving through a viscous medium with comparatively low velocities, the ions in metallic conductors are electric corpuscles moving with high velocities more after the manner postulated in the kinetic theory of gases. It is easy to see that this theory will give similar numerical results to the electronic theory when similar assumptions are made in the course of the work. But it has the advantage of greater latitude in explaining the vagaries of sign of the Hall effect, and many other peculiarities in the variation of resistance and thermoelectric power with temperature. For good conductors, like the pure metals, we may suppose, on the electrolytic analogy, that the dissociation is practically complete, so that the ratio of the conductivities will approach the value calculated on the assumption that all the carriers of heat are also carriers of electricity. But in bad conductors the dissociation will be far from complete, and it is possible to see why, for instance, the electric resistance of cast-iron should be nearly ten times that of pure iron, although there is comparatively little difference in their thermal conductivities. The numerical magnitude of the thermoelectric effect, which is commonly quoted in explanation of the deviation of alloys from the electronic theory, is far too small to produce the required result; and there is little or no correspondence between the thermo-electric properties of the constituents of alloys and the variations of their electric conductivities.

One of the oldest difficulties of the material theory of heat is to explain the process of the production of heat by friction. The application of the general principle of the conservation of energy leads to the undoubted conclusion that the thermal energy generated is the equivalent of the mechanical work spent in friction, but throws little or no light on the steps of the process, and gives no information with regard to the actual nature of the energy produced in the form of heat. It follows from the energy principle that the quantity of caloric generated in the process is such that its total energy at the final temperature is equal to the work spent. If a quantity of caloric represents so many neutral molecules of electricity, one cannot help asking where they came from, and how they were produced. It is certain that in most cases of friction, wherever slip occurs, some molecules are torn apart, and the work spent is represented in the first instance by the separation of electric ions. Some of these ions are permanently separated as frictional electricity, and can be made to perform useful work; but the majority recombine before they can be effectively separated, leaving only their equivalent in thermal energy. The recombination of two ions is generally regarded simply as reconstituting the original molecule at a high temperature, but in the light of recent discoveries we may perhaps go a step further. It is generally admitted that X or γ rays are produced by the sudden stoppage of a charged corpuscle, and Lorentz, in his electron theory of radiation, has assumed that such is the case however low the velocity of the electron. A similar effect must occur in the sudden stoppage of a pair of ions rushing together under the influence of their mutual attraction. Rays produced in this way would be of an exceedingly soft or absorbable character, but they would not differ in kind from those produced by electrons except that their energy, not exceeding that of a pair of ions, would be too small to produce ionisation, so that they could not be detected in the usual way. If the X rays are corpuscular in their nature, we cannot logically deny the corpuscular character even to the slowest moving rays. We know that X rays continually produce other X rays of lower velocity. The final stage is probably reached when the average energy of an X corpuscle or molecule of caloric is the same as that of a gas molecule at the same temperature, and the number of molecules of caloric generated is such that their total energy is equal to the work originally spent in friction.

In this connection it is interesting to note that Sir J. J. Thomson, in a recent paper on ionisation by moving particles, has arrived, on other grounds, at the conclusion that the character of the radiation emitted during the recombination of the ions will be a series of pulses, each pulse containing the same amount of energy and being of the same type as very soft X rays. If the X rays are really corpuscular, these definite units or quanta of energy generated by the recombination of the ions bear a close resemblance to the hypothetical molecules of caloric.

It may be objected that in many cases of friction, such as internal or viscous friction in a fluid, no electrification or ionisation is observable, and that the generation of caloric cannot in this case be attributed to the recombination of ions. It must, however, be remarked that the generation of a molecule of caloric requires less energy than the separation of two ions; that, just as the separation of two ions corresponds with the breaking of a chemical bond, so the generation of one or more molecules of caloric may correspond with the rupture of a physical bond, such as the separation of a molecule of vapour from a liquid or solid. The assumption of a molecular constitution for caloric follows almost of necessity from the molecular theories of matter and electricity, and is not inconsistent with any well-established experimental facts. On the contrary, the many relations which are known to exist between the specific heats of similar substances, and also between latent heats, would appear to lead naturally to a molecular theory of caloric. For instance, it has often been noticed that the molecular latent heats of vaporisation of similar compounds at their boiling-points are proportional to the absolute temperature. It follows that the molecular latent caloric of vaporisation is the *same* for all such compounds, or that they require the same number of molecules of caloric to effect the same change of state, irrespective of the absolute temperatures of their boiling-points. From this point of view one may naturally regard the liquid and gaseous states as conjugate solutions of caloric in matter and matter in caloric respectively. The proportion of caloric to matter varies regularly with pressure and temperature, and there is a definite saturation limit of solubility at each temperature.

One of the most difficult cases of the generation of caloric to follow in detail is that which occurs whenever there is exchange of heat by radiation between bodies at different temperatures. If radiation is an electro-magnetic wave-motion, we must suppose that there is some kind of electric oscillator or resonator in the constitution of a material molecule which is capable of responding to the electric oscillations. If the natural periods of the resonators correspond sufficiently closely with those of the incident radiation the amplitude of the vibration excited may be sufficient to cause the ejection of a corpuscle of caloric. It is generally admitted that the ejection of an electron may be brought about in this manner, but it would evidently require far less energy to produce the emission of a neutral corpuscle, which ought therefore to be a much more common effect. On this view, the conversion of energy of radiation into energy of caloric is a discontinuous process taking place by definite molecular increments, but the absorption or emission of radiation itself is a continuous process. Prof. Planck, by a most ingenious argument based on the probability of the distribution of energy among a large number of similar electric oscillators (in which the entropy is taken as the logarithm of the probability, and the temperature as the rate of increase of energy per unit of entropy), has succeeded in deducing his well-known formula for the distribution of energy in full radiation at any temperature; and has recently, by a further extension of the same line of argument, arrived at the remarkable conclusion that, while the absorption of radiation is continuous, the emission of radiation is discontinuous, occurring in discrete elements or quanta. Where an argument depends on so many intricate hypotheses and analogies the possible interpretations of the mathematical formulæ are to some extent uncertain; but it would appear that Prof. Planck's equations are not necessarily inconsistent with the view above expressed that both emission and absorption of radiation are continuous, and that his *elementa quanta*, the energy of which varies with their frequency, should rather be identified with the molecules of caloric, representing the conversion of the electro-magnetic energy of radiation into the form of heat, and possessing energy in proportion to their temperature.

Among the difficulties felt, rather than explicitly stated, in regarding entropy or caloric as the measure of heat quantity is its awkward habit of becoming infinite, according to the usual approximate formulæ, at extremes of pressure or temperature. If caloric is to be regarded as the measure of heat quantity, the quantity existing in a finite body must be finite, and must vanish at the absolute zero of temperature. In reality there is no experimental foundation for any other conclusion. According to the usual gas formulæ it would be possible to extract an infinite quantity of caloric from a finite quantity of gas by compressing it at constant temperature. It is true that (even if we assumed the law of gases to hold up to infinite pressures, which is far from being the case) the quantity of caloric extracted would be of an infinitely low order of infinity as compared with the pressure required. But, as a matter of fact, experiment indicates that the quantity obtainable would be finite, although its exact value cannot be calculated owing to our ignorance of the properties of gases at infinite pressures. In a similar way, if we assume that the specific heat as ordinarily measured remains constant, or approaches a finite limit at the absolute zero of temperature, we should arrive at the conclusion that an infinite quantity of caloric would be required to raise the temperature of a finite body from 0° to 1° absolute. The tendency of recent experimental work on specific heats at low temperatures, by Tilden, Nernst, Lindemann, and others, is to show, on the contrary, that the specific heats of all substances tend to vanish as the absolute zero is approached, and that it is the specific capacity for caloric which approaches a finite limit. The theory of the variation of the specific heats of solids at low temperatures is one of the most vital problems in the theory of heat at the present time, and is engaging the attention of many active workers. Prof. Lindemann, one of the leading exponents of this work, has kindly consented to open a discussion on the subject in our section. We are very fortunate to have succeeded in securing so able an exponent, and shall await his exposition with the greatest interest. For the present I need only add that the obvious conclusion of the caloric theory bids fair to be completely justified.

A most interesting question, which early presented itself to Rumford and other inquirers into the caloric theory of heat, was whether caloric possessed *weight*. While a positive answer to this question would be greatly in favour of a material theory, a negative answer, such as that found by Rumford, or quite recently by Profs. Poynting and Phillips, and by Mr. L. Southerns working independently, would not be conclusively against it. The latter observers found that the change in weight, if any, certainly did not exceed 1 in 10^8 per 1° C. If the mass of a molecule of caloric were the same as that generally attributed to an electron, the change of weight, in the cases tested, should have been of the order of 1 in 10^7 per 1° C., and should not have escaped detection. It is generally agreed, however, that the mass of the electron is entirely electro-magnetic. Any such statement virtually assumes a particular distribution of the electricity in a spherical electron of given size. But if electricity itself really consists of electrons, an argument of this type would appear to be so perfectly circular that it is questionable how much weight should be attached to it. If the equivalent mass of an electron in motion arises slowly from the electromagnetic field produced by its motion, a neutral corpuscle of caloric should not possess mass or energy of translation as a whole, though it might still possess energy of vibration or rotation of its separate charges. For the purpose of mental imagery we might picture the electron as the free or broken end of a vortex filament, and the neutral corpuscle as a vortex ring produced when the positive and negative ends are united; but a mental picture of this kind does not carry us any further than the sphere coated with electricity, except in so far as either image may suggest points for experimental investigation. In our ignorance of the exact mechanism of gravity it is even conceivable that a particle of caloric might possess mass without possessing weight, though, with the possible exception of the electron, nothing of the kind has yet been demonstrated. In any case it would appear that the mass, if any, associated with a quantity of caloric must be so small that we could not hope to learn much about it by the direct use of the balance.

The fundamental property of caloric, that its total quantity cannot be diminished by any known process and that it is not energy but merely the vehicle or carrier of energy, is most simply represented in thought by imagining it to consist of some indestructible form of matter. The further property, that it is always generated in any turbulent or irreversible process, appears at first sight to conflict with this idea, because it is difficult to see how anything indestructible can be so easily generated. When, however, we speak of caloric as being generated, what we really mean is that it becomes associated with a material body in such a way that we can observe and measure its quantity by the change of state produced. The caloric may have existed previously in a form in which its presence could not be detected. In the light of recent discoveries we might suppose the caloric generated to arise from the disintegration of the atoms of matter. No doubt some caloric is produced in this way, but those corpuscles that are so strongly held as to be incapable of detection by ordinary physical methods require intense shocks to dislodge them. A more probable source of caloric is the æther, which, so far as we know, may consist entirely of neutral corpuscles of caloric. The hypothesis of a continuous æther has led to great difficulties in the electromagnetic theory of light and in the kinetic theory of gases. A molecular, or cellular-vortex, structure appears to be required. According to the researches of Kelvin, Fitzgerald, and Hicks, such an æther can be devised to satisfy the requirements of the electromagnetic theory without requiring it to possess a density many times greater than that of platinum. So far as the properties of caloric are concerned, a neutral pair of electrons would appear to constitute the simplest type of molecule, though without more exact knowledge of the ultimate nature of an electric charge it would be impossible to predict all its properties. Whether an æther composed of such molecules would be competent to discharge satisfactorily all the onerous functions expected from it, may be difficult to decide, but the inquiry, in its turn, would probably throw light on the ultimate structure of the molecule.

Without venturing too far into the regions of metaphysical speculation, or reasoning in vicious circles about the nature of an electric charge, we may at least assert with some degree of plausibility that material bodies under ordinary conditions probably contain a number of discrete physical entities, similar in kind to X rays or neutral corpuscles, which are capable of acting as carriers of energy, and of preserving the statical equilibrium between matter and radiation at any temperature in virtue of their interchanges with electrons. If we go a step further and identify these corpuscles with the molecules of caloric, we shall certainly come in conflict with some of the fundamental dogmas of the kinetic theory, which tries to express everything in terms of energy, but the change involved is mainly one of point of view or expression. The experimental facts remain the same, but we describe them differently. Caloric has a physical existence, instead of being merely the logarithm of the probability of a complex ion. In common with many experimentalists, I cannot help feeling that we have everything to gain by attaching a material conception to a quantity of caloric as the natural measure of a quantity of heat as opposed to a quantity of heat energy. In the time at my disposal I could not pretend to offer you more than a suggestion of a sketch, an apology for the possibility of an explanation, but I hope I may have succeeded in conveying the impression that a caloric theory of heat is not so entirely unreasonable in the light of recent experiment as we are sometimes led to imagine.

NOTES.

DR. G. T. BEILBY, F.R.S., has been appointed a member of the Royal Commission on Oil Fuel in succession to the late Dr. H. Owen Jones.

THE death is announced, at eighty years of age, of Prof. T. Gomperz, of the University of Vienna, distinguished by his studies in philology and philosophy, and well known by his work "Greek Thinkers," of which an English translation appeared several years ago.

As previously announced, the autumn meeting of the Institute of Metals will be held in London on Wednesday and Thursday, September 25 and 26. The following are among the papers that are expected to be submitted:—Autogenous welding by means of oxygen and acetylene of copper and its principal alloys, and of aluminium, Prof. F. Carnevali; the effect of other metals on the structure of the beta constituent in copper-zinc alloys, Prof. H. C. H. Carpenter; the effect of temperatures higher than atmospheric on tensile tests of copper and its alloys, Prof. A. K. Huntington; the influence of oxygen on the properties of metals and alloys, E. F. Law; the annealing of coinage alloys, Dr. T. Kirke Rose; intercrystalline cohesion in metals (with an appendix on the formation of twinned crystals in silver), Dr. W. Rosenhain and D. Ewen; oxygen in brass, Prof. T. Turner.

WE regret to announce that Prof. T. Winter, professor of agriculture in University College of North Wales, Bangor, died on Sunday, September 1, at forty-six years of age. Prof. Winter was educated at Darlington Grammar School and Edinburgh University, where he graduated in arts. He afterwards became assistant lecturer on agriculture at the University College of North Wales. Later he was appointed lecturer in agriculture at the University of Leeds; and in 1894 he returned to the University College of North Wales as head of the agricultural department. He took an active part in agricultural matters in Wales, and was widely known and respected throughout the country.

WE are glad to see that progress is gradually being made with the synchronisation of clocks, thanks largely to the enterprise of private companies. Last year a committee of the British Science Guild presented a valuable report upon the position of the subject and the system employed by the General Post Office, and an instructive account of synchronisation and the importance of correct time is given by Major O'Meara in an address printed in this year's report of the Guild. The committee recommended that, as a beginning, it would probably be well to have a few large public clocks in London synchronised, and that these should be set apart and considered as "standard time clocks." An electric clock which may be used for the purpose suggested by the committee has just been built by the Silent Electric Clock Co., 192 Goswell Road, London, E.C., on the new mills of the Hovis Bread Co., Vauxhall Bridge Road. We understand that this electric clock, with its four faces each 9 ft. 6 in. diameter, is not only the largest electric clock in London, but is also to be controlled by a master clock directly synchronised from Greenwich. The clock thus represents an up-to-date form of public timekeeper which is likely to be extensively adopted in the future.

A LOCAL society which possesses such a creditable record of work as the Royal Cornwall Polytechnic Society does well to commemorate worthies who were members of their body. In the first part of its Proceedings for 1912 it publishes portraits and lives of three of its most eminent members, Sir C. Lemon, F.R.S., first president (1833–67), who did good service to science by his attempt to found a school of mines at Truro, a project which was in advance of the times when it was proposed, but has been since realised; Lord de Dunstanville, first patron, scholar and politician; and last, but not least, Davies Gilbert, who succeeded Sir Humphry Davy as president of the Royal Society, an accomplished botanist and distinguished in other branches of science. In the annual report the council takes occasion to congratulate the Rev. Philip Carlyon, a former vice-president of the society, on attaining the age of a hundred years in December last.

VOLUME xi. of the Zoological Publications of the Field Museum is devoted to an account of the mammals of Illinois and Wisconsin, comprising 502 pages of text and a large number of illustrations. "Keys" to the various genera and their species are given.

IN the report of the Field Museum of Natural History, Chicago, for 1911, the director refers to the acquisition by the trustees of a site for a new building in Jackson Park, immediately to the north of the present structure. The plans for the new building have been approved, and the specifications for the contracts drawn up. The report is illustrated with photographs of bird groups and other interesting exhibits recently added to the museum.

THE Meteorological Service of Canada has issued a very useful pamphlet on the comparison of the Ångström pyrheliometer and the Callendar sunshine recorder, and the determination of the proportion of heat received on a horizontal surface from the diffuse radiation from the sky to that received from the sun. The International Union for Cooperation in Solar Research at its Oxford conference recommended (1) the adoption of the former instrument, and (2) comparisons between it and other standard instruments, but except at laboratories and the larger observatories little is yet generally known about its working. The paper in question, prepared by Mr. J. Patterson, under the direction of Mr. R. F. Stupart, gives a very clear idea of the construction and action of both the above instruments. The following are among the noteworthy features shown by their comparison: (1) the maximum intensity of radiation measured by the Ångström instrument occurred at apparent noon, and by the Callendar recorder about forty minutes later. (2) The Ångström instrument gave slightly higher values in the afternoon than in the morning, and the Callendar recorder much higher values. (3) In the early morning and late afternoon the Callendar instrument gave higher readings than the Ångström. (4) Excluding the morning readings the greatest percentage difference occurred between 9h. and 10h. a.m.; from about 1h. to 3h. p.m. the change in percentage was very slight.

SIR T. L. HEATH has now supplied an English edition (Cambridge Press, 2*s.* 6*d.*) of the "Method" of Archimedes, discovered by Heiberg in 1906. This tract is of very great interest, because it gives mechanical discussions of geometrical problems based upon the principle of the lever. Thus we have the rule for the quadrature of a parabolic segment which Archimedes elsewhere proves by the method of exhaustion. Archimedes expressly says that the "Method" does not supply demonstrations; he does not give any reasons, but no doubt he had in mind what we should call the theory of infinitesimals of different orders. For example, a triangular lamina may be roughly, but not exactly, replaced by a set of parallel rectangular strips; to find the centroid of the triangle we must find the *limiting* position of the centroid of the system of strips. Among other noteworthy points it may be observed that Archimedes arrived at the formula for the volume of a sphere before he discovered that for its area; and that he attributes to Democritus the discovery of the theorem that pyramids of equal bases and altitudes are of equal volume. The first proof, allowed to be rigorous, he assigns (as elsewhere) to Eudoxus. As usual, the editor's task is performed with great learning and thoroughness; his introduction in particular will be found extremely useful by those who are not familiar with Greek mathematics beyond the elementary stage.

The Central—the journal of the City and Guilds Engineering College—for August contains an article advocating the use of direct rather than alternating currents in electric traction by Mr. L. Calisch, an account of some recent improvements in vacuum evaporation by Mr. W. A. Davis, and a description of the Boncourt system of gaseous combustion by one of its inventors, Mr. C. D. McCourt. The feature of the system is the combustion of the gas and air mixture as it is passing with the requisite velocity through the interstices of a granular refractory material. A steam boiler fired in this way evaporates 16 lbs. of water per hour per square foot of heating surface. The old student notes occupy fifteen pages. Referring to work in the drawing office of a French engineering firm, Mr. K. C. Barnaby writes:—". . . there is the delightful metric system. I cannot imagine anyone who has worked and calculated in a Continental office who would not wish our antiquated system of weights and measures—well, where parallels meet."

The fifty-seventh annual exhibition of the Royal Photographic Society, which was opened last Monday, will remain open until the 21st inst. at the Gallery of the Royal Society of British Artists, Suffolk Street, Pall Mall. In the scientific and technical sections four exhibits have been awarded medals. The first consists of examples of a new photo-mechanical process by Mr. A. E. Bawtree, who has found a method of transferring the pigment of an impression from an engraved plate, whether it is old or new, to a sheet of glass, so producing a more perfect transparency than any camera method can yield. He claims that not a grain of the pigment is lost. From this transparency copies of the original may be made by various photographic or photo-mechanical methods as is well known. He can then retransfer the pigment from the glass to paper without the loss of even the finest detail. The method of transfer is so easy that the author does not yet describe it, because it enables facsimiles of bank-notes and such documents to be prepared with a very moderate outlay for apparatus. Dr. D. H. Hutchinson's series of photomicrographs of the ova of the Mexican Axolotl show the development of the embryo from the first day after the egg has been laid up to the time of its escape from the egg. This, and Mr. Farren's series of photographs of the little egret, and Mr. G. Busby's autochrome landscape, well deserve the medals that have been awarded them. Among the numerous other exhibits we may perhaps direct special attention to the radiographs of Dr. Hall-Edwards, which show the effect of bismuth salts and iodoform in indicating details with great clearness, Dr. Thurstan Holland's "plastic" radiographs, Dr. T. W. Butcher's high-power photomicrographs, and Dr. Rodman's stereo-photomicrographs of the scales on the wings of moths and butterflies and the hairs on the leaves of plants, though it seems almost invidious to do so where so much good work is shown illustrating many different branches of work.

Parts ii. and iii. of the Subject List of Works on Mineral Industries in the Library of the Patent Office have just been published at the office, 25 Southampton Buildings, Chancery Lane, W.C., price sixpence each. Part ii. contains classified titles of works on iron manufacture, alloys, and metallography, and part iii. those relating to metallurgy (non-ferrous and general), assaying, and fuel combustion. The lists, like others in the same series, are most helpful guides to the contents of a very valuable library.

OUR ASTRONOMICAL COLUMN.

The Spectrum of Brooks's Comet, 1911c.—Some excellent spectrograms of comet 1911c are reproduced and their special features discussed by MM. de la Baume Pluvinel and Baldet in the September number of *L'Astronomie*. The spectrographs employed were mounted at the Juvisy Observatory, and an examination of the complete series of plates shows very markedly the spectral changes which took place as the comet approached the sun; between August and the end of October a number of "unknown" radiations between λ 4100 and λ 4000 suffered a considerable diminution of intensity as compared with other radiations. The wave-lengths of these lines, considered precise to 1 Å, are 4099, 4074, 4065, 4051, 4041, 4032, and 4016. These radiations were peculiar to the nucleus of the comet, being found neither in the coma nor the tail, and as they became fainter the tail radiations became strong; it was also noted that in the later spectra the tail radiations extended well to the front of the comet's head, showing that in active comets, such as this one and Morehouse's, the tail matter is expelled in all directions. In Kiess's comet it appeared to escape from one point only. Altogether 47 monochromatic images of the nucleus were counted on the Juvisy plates, but the kathode spectrum of nitrogen was not recognised among them.

The Corona at the Total Solar Eclipse of April 17.—A drawing of the corona, made by Señor J. Comas Solá, at Barco de Valdeorras (Galicia), on April 17, appears in No. 4597 of the *Astronomische Nachrichten*. Although observers at other stations were uncertain as to the definite apparition of the corona, Señor Comas Solá saw it well extended, and on his drawing depicts it extending equatorially to about $2\frac{1}{2}$ solar diameters on either side of the sun. The drawing, given principally to show the general form, represents a corona distinctly of the minimum type. The same observer also describes his spectrum observations, while many others give the results of observations of the contacts, &c.

The Diameter of Neptune.—An interesting paper by Dr. G. Abetti, discussing the various measures of Neptune made since 1846, appears in No. 8, vol. i. (second series), of the *Memorie della Società degli Spettroscopisti Italiani*. He shows that the measured diameter has, in general, tended to become less as the aperture and magnification employed have increased. Using only the results from apertures of more than 40 c.m. and magnifications greater than 620, the mean values being 76 c.m. and 794 respectively, the diameter at unit distance comes out as $69{\cdot}04''$ for the mean aperture, and $68{\cdot}98''$ for the mean power; other considerations show that the true value differs but little from $69''$. Using this value, he then calculates the true diameter as 5×10^4 km., the density (earth = 1) as 0·29 or (water = 1) 1·6, and the superficial gravity as 1·12, that at the earth's equator being taken as 1·0. As seen from the earth, the apparent diameter ranges between $2{\cdot}39''$ and $2{\cdot}20''$.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Birmingham.—The University has suffered a severe loss by the death of the Vice-Chancellor, Alderman Charles Gabriel Beale, at the early age of 69. Alderman Beale, who was a graduate of Trinity College, Cambridge, was one of the most prominent citizens of Birmingham, having been elected to the mayoral chair no fewer than four times. He was mainly instrumental in carrying to a successful conclusion the great scheme for supplying the city with water from the Welsh mountains. He was, from the outset, a most energetic supporter of the movement for establishing a University in Birmingham, and was largely responsible for the working-out of the scheme, for which his legal training and experience qualified him in an unusual degree. When the University became an accomplished fact in 1900, his services to the cause were fittingly recognised by his appointment as the first Vice-Chancellor. His ideas were on a large scale, and he believed in the importance of associating the University with buildings which by their imposing size and appearance should appeal to local patriotism and serve to keep before the inhabitants of a great industrial centre the claims of higher education. Within the University he was known to the undergraduates for his special interest in their social welfare.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 26.—M. A. Bassot in the chair.—Edouard **Heckel**: The cultural bud mutation of *Solanum tuberosum*. An account of experiments in the cultivation of wild potato plants from Chile, Bolivia, and Peru. The tubers produced from the cultivated plants were edible, and contained a greater amount of starch than the wild plants. The tubercles from Bolivia showed the characters of mutation; those from other sources appeared to be in course of mutation.—W. H. **Young**: The summability of a function of which the Fourier's series is given.—B. **Bianu** and L. **Wertenstein**: An ionising radiation, attributable to the radio-active recoil, emitted by polonium. It was found to be necessary to use a polonium film in these experiments not exceeding $10\mu\mu$ in thickness. The curves obtained with a silver disc covered with this thin polonium layer, in presence of a transversal magnetic field of 1100 units, were analogous with those obtained in the case of radium C, and show clearly the existence of an absorbable radiation.—J. **Bougault**: Benzylpyruvic acid. The acid was prepared by the action of alkaline solutions on phenyl-α-oxycrotonamide. The yields of benzylpyruvic acid were good. The condensation products of this acid with itself and with acetone were also studied.—H. **Vincent**: The active immunisation of man against typhoid fever. Details of five cases are given which show that inoculations of typhovaccin have a preventive power not only against subsequent absorption of typhoid cultures, but also against a recent infection anterior to the inoculation.—Charles **Nicolle**, L. **Blaizot**, and E. **Conseil**: The conditions of transmission of recurrent fever by the flea. The evidence is against the assumption of hereditary transmission in the flea. Details are given of studies in the necessary conditions for infection.—J. **Wolff**: The stimulating action of alkalies and of ammonia in particular on peroxydase.—P. **Chaussé**: The vitality of the tubercle bacillus tested by inoculation and by inhalation.

BOOKS RECEIVED.

Notes on Algebra. By A. F. van der Heyden. Pp. viii+133. (Middlesbrough: W. Appleyard and Sons, Ltd.) 2*s*. 6*d*.

Exercises in Modern Arithmetic. By H. S. Jones. Pp. x+336. (London: Macmillan and Co., Ltd.) 2*s*. 6*d*.

British Rainfall, 1911. By Dr. H. R. Mill. Pp. 388. (London: E. Stanford, Ltd.) 10*s*.

Life Understood from a Scientific and Religious Point of View, &c. By F. L. Rawson. Pp. xv+660. (London: The Crystal Press, Ltd.) 7*s*. 6*d*. net.

Identification of the Economic Woods of the United States. By Prof. S. J. Record. Pp. vii+117+6 plates. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 5*s*. 6*d*. net.

Forestry in New England. By Profs. R. C. Hawley and A. F. Hawes. Pp. xv+479. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 15*s*. net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the year ending June 30, 1912. New Series. I. Edited by Prof. A. Meek. (Newcastle-on-Tyne: Cail and Sons.) 5*s*.

Catalogue of the Periodical Publications including the Serial Publications of Societies and Governments in the Library of University College, London. By L. Newcombe. Pp. vii+269. (Oxford: H. Hart.)

Catalogue of the Periodical Publications in the Library of the Royal Society of London. Pp. viii+455. (London: H. Frowde.)

Results of the Magnetical and Meteorological Observations made at the Royal Alfred Observatory, Mauritius, in the year 1902. Pp. xxii+lxxviii+5 plates. Ditto, 1903. Pp. xxi+lxxiv+7 plates. Ditto, 1908. Pp. xxv+lxxxviii+6 plates. (Mauritius.)

An Introduction to the Study of the Protozoa, with special reference to the Parasitic Forms. By Prof. E. A. Minchin. Pp. xi+520. (London: E. Arnold.) 21*s*. net.

Eugenics and Public Health. By Prof. K. Pearson. Pp. 34. (London: Dulau and Co., Ltd.) 1*s*. net.

Darwinism, Medical Progress, and Eugenics. The Cavendish Lecture, 1912. By Prof. K. Pearson. Pp. 29+7 plates. (London: Dulau and Co., Ltd.) 1*s*. net.

Instinct and Experience. By Prof. C. Lloyd Morgan. Pp. xvii+299. (London: Methuen and Co., Ltd.) 5*s*. net.

Lebensbild eines Naturforschers. By E. du Bois-Reymond. Zweite Auflage. Pp. 50. (Brackwede i.W: Dr. W. Breitenbach.) 80 pfennigs.

Grundriss der Biochemie für Studierende und Aerzte. By Prof. C. Oppenheimer. Pp. vii+399. (Leipzig: G. Thieme.) 9 marks.

The Boy's Playbook of Science. By J. H. Pepper. Revised, &c., by Dr. J. Mastin. Pp. x+680. (London: G. Routledge and Sons, Ltd.) 5*s*.

Dana's Manual of Mineralogy. Thirteenth edition. By Prof. W. E. Ford. Pp. viii+460. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 8*s*. 6*d*. net.

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

No. 2237, Vol. 90] THURSDAY, SEPTEMBER 12, 1912 [Price Sixpence

Registered as a Newspaper at the General Post Office.]

THURSDAY, SEPTEMBER 12, 1912.

THERMODYNAMICS OF THE ATMOSPHERE.

Thermodynamik der Atmosphäre. By Dr. A. Wegener. Pp. viii+331. (Leipzig: J. A. Barth, 1911.) Price 11 marks.

THE progress of a science depends upon the intellectual calibre of the men who pursue it: that determines what shall be written for them as well as by them. It is therefore significant for meteorology that a text-book on the thermodynamics of the atmosphere should be added to a collection recently enriched by treatises on meteorological optics and on the foundations of dynamical meteorology. Special phases of the subject have been treated at some length by Helmholtz, Hertz, von Bezold, and others, but their papers are scattered among different scientific journals, rarely accessible in a single library. Dr. Wegener's treatise, which has been written with the object of giving a systematic account of the existing knowledge and methods, should therefore be generally welcomed.

In an introductory chapter the author deals with the constitution of the atmosphere, and discusses in interesting fashion the extreme heights at which ...us optical phenomena, aurora, meteors, and ...liacal light appear. He finds that in all cases the values lie roughly between 70 and 100 km., or in the layer in which the nitrogen atmosphere is changing to the hydrogen atmosphere. After an account of the thermodynamics of an ideal gas and its application to a consideration of the precise proportions in which different gases exist at different heights, he indulges in some speculation about the existence of a hypothetical gas, geocoronium, above the hydrogen atmosphere. Such speculation is out of place in a text-book, and the same criticism applies to the statement that the stratosphere extends from 11 to 70 km. There is no evidence as to the upper limit of the temperature conditions characteristic of the stratosphere.

In the third section the different phases of water vapour, the condensation on nuclei, and the formation of crystals are discussed thoroughly and comprehensively.

The fourth and fifth sections, which comprise rather more than two-thirds of the book, are undoubtedly the most valuable parts of the work. In them the author treats of the thermodynamics of adiabatic changes and of the physics of clouds respectively. The effect of the condensation of water vapour in diminishing the vertical temperature gradient for air rising adiabatically is important both in the general circulation and in local disturbances, and it is usually put forward as the explanation of the Föhn. The cooling of the air which rises on the windward side of the mountains is influenced by the condensation and precipitation of the water which it contains. This air descends on the lee side, where there is no moderating effect on the vertical temperature gradient, and is consequently hot and dry. Dr. Wegener deduces, from the fact that the average vertical gradient is less than that corresponding to the adiabatic gradient either for saturated or for dry air, that the rising of the air on the windward side actually exerts a moderating influence on the Föhn.

A very full account is given of "inversions," *i.e.* cases in which the temperature remains constant or increases with increasing altitude. Their connection with waves and wave-clouds is discussed at length, and the form of the surface between currents of different densities and velocities is made the subject of mathematical investigation. A chapter is devoted to the stratosphere. The different types of the temperature-height curve between the troposphere and stratosphere are illustrated by an excellent diagram derived by Schmauss from a consideration of the results obtained at Munich. In the discussion of the meteorological conditions in the stratosphere itself it is assumed that the relative humidity at the base of the stratosphere, the region of minimum temperature, is 50 per cent. As there is no process by which the nitrogen-oxygen atmosphere is "dried" except by the precipitation of water condensed by cooling, it is not easy to see how a relative humidity of 50 per cent. could be obtained at the place of minimum temperature, where diffusion and convection would both tend to produce saturation.

The discussion of clouds is excellent. It includes a note on the rate of fall of drops and its connection with the passage from cloud to rain. The photographs of the different forms of clouds, some of which were taken from balloons above the clouds, are well reproduced, and add considerably to the educational value of the descriptive matter and the theoretical discussion.

Dr. Wegener has performed a signal service in producing a good book on a branch of the subject which had not previously been dealt with systematically. The work as a whole loses by the deliberate exclusion of radiation, which is fundamentally and indissolubly connected with the application of thermodynamic considerations to the problems which confront the meteorologist every day. The author regards it, however, as a subject for separate treatment.

THE STORY OF "EIGHT DEER."

The Story of "Eight Deer" in Codex Colombino. By J. Cooper Clark. Pp. 33+plates A–J (coloured). (London: Taylor and Francis, 1912.) Price 21*s.* net.

AMONG the papers presented to the International Congress of Americanists during the session held in London at the end of last June was a pamphlet by Mr. J. Cooper Clark entitled "The Story of 'Eight Deer' in the Codex Colombino." This is an attempt to throw some light into the obscurity of the pre-Columbian American manuscripts.

Mr. Cooper Clark commenced his researches with a careful examination of the Codex Colombino, a picture-writing painted on prepared deerskin, folded like a screen, and measuring 6·80 metres in length when spread open, now preserved in the National Museum in the City of Mexico. In this manuscript Mr. Cooper Clark traced the history of a warrior chieftain named "Eight Deer." All the personages identified by Mr. Cooper Clark in this codex are named after days of the month, and the name "Eight Deer" is expressed by a deer's head with the numeral eight (that is, by eight round discs) attached to it, a deer's head (Maçatl) being one of the twenty day signs of the Nahua month, and according to the Nahua method of noting time, this date would occur only once in a cycle of fifty-two years. It is not, however, explained why this particular day was chosen as the name of the warrior, although it is stated that it was not the day of his birth.

The life-history of Eight Deer is most ingeniously traced through the pages of the codex, but the most interesting fact established by Mr. Cooper Clark is that the history of the same individual is also told in five of the other extant pre-Columbian codices, namely, the Zouche (British Museum), the Vienna, the Bodleian, the Baker, and the Selden. By a careful comparison of these codices, Mr. Cooper Clark has not only been able to show that in part they tell the same story, but to supply incidents in the history of Eight Deer which are missing from the Codex Colombino owing to the destruction of a part of the manuscript.

Mr. Cooper Clark has further come to the conclusion that Eight Deer can be identified as the glyph attached to the figure of a warrior carved on one of the stone slabs from Monte Alban in Oaxaca (in the Zapotec country), now exhibited in the National Museum of Mexico, and from this he argues that the codices dealing with the story of Eight Deer must be of Zapotec and not Aztec origin, adding, "Not many Nahua codices are likely to have survived the destruction by Archbishop Zumárraga of the temple libaries of Tenochtitlan, Texcoco, and the other cities around the lakes, whereas, warned by the example of Mexico, the Zapotecs would have had ample time to secrete their records."

There is no difficulty in fixing the dates mentioned in the Codex Colombino within the fifty-two year cycle; the difficulty arises in determining in which cycle of fifty-two years the dates occur. If the events depicted are placed in the next cycle before the arrival of the Spaniards, the birth of Eight Deer would have taken place in the year 1491 A.D.; but Mr. Cooper Clark thinks that it more probably took place in the previous cycle, when the date would correspond to 1439 A.D.

The pamphlet is illustrated with plates most carefully drawn and coloured from the original manuscripts, showing how the same events in the life of Eight Deer are depicted in the Colombino, Zouche, Bodleian, and Becker codices.

Mr. Cooper Clark is to be heartily congratulated on his most painstaking achievement. The pamphlet was written for the few who are interested in ancient American civilisations, and can only be fully appreciated by those who have access to copies of the codices discussed; but even to the general reader it must be of interest as showing a native American method of recording historical events, and, moreover, as demonstrating how, by careful and intelligent examination and comparison, order and meaning may be evolved from the most obscure and unpromising material.

SUBMERGED RIVER-VALLEYS.

Monograph on the Sub-Oceanic Physiography of the North Atlantic Ocean. By Prof. Edward Hull, F.R.S. With a Chapter on the Sub-Oceanic Physical Features off the Coast of North America and the West Indian Islands, by Prof. J. W. W. Spencer. Pp. viii+41+xi plates. (London: E. Stanford, 1912.) Price 21*s.* net.

THIS is a folio publication with eleven excellent maps and nine short chapters of explanatory text, and an additional chapter by Prof. J. W. Winthrop Spencer. The author has based the work on a detailed study of the Admiralty charts showing the soundings over the continental shelf and the upper part of the continental slope off the western coasts of Europe and Africa, and this leads up to a statement of his views as to the cause of the Glacial Period.

It is pointed out that there are two principal schools of geographical evolution, the one believing that the ocean basins and the position of the chief continental areas retain traces of their primeval structure and have undergone only slight modification, the other, to which the author belongs, believing that land and sea have changed places at various geological periods. The latter view, he considers, is upheld by a consideration of the distribution of geological formations on both sides of the North Atlantic.

A detailed description is then given of the submerged river-valleys occurring off western Europe and Africa and in the Mediterranean as traced from the soundings shown on the charts. These were formed not only by rivers, the greater part of the course of which is visible on land, such as the Loire and the Congo, but also by rivers which rose on land now completely submerged, such as the "Irish Channel River" and the "English Channel River." They all indicate a former great uplift of land. The Norwegian fjords also are regarded as river-valleys of great geological age.

Professor Spencer shows that the continental shelf off the east coast of America is likewise cut up by submarine river-valleys and that there was a land connection between the West Indies and the American continent, and he upholds the view that great changes of level, amounting in some cases to thousands of feet, have taken place in recent geological times.

In the final chapter Prof. Hull gives his explanation of the cause of the Glacial Period. As shown from a study of the submerged river-valleys, a general elevation of the earth's crust took place all round the North Atlantic, the date of which is concluded to be about the close of the Tertiary Period. This brought about a much colder climate and at the same time a great change in the direction and temperature of the Gulf Stream. When the Antilles were directly connected with the American continent this current could not enter the Caribbean Sea, where at present it gains about 13° Fahrenheit of temperature; hence arose an additional cause for decreased temperature along all the coasts of the North Atlantic. The combined effect of these two factors, viz., the increased elevation of land on both sides of the Atlantic and the decrease of temperature in the Gulf Stream, would be sufficient, the author considers, to call into existence a rigorous glacial climate over the northern parts of America and Europe, which in its turn would affect a great part of the rest of Europe and western Asia, and more or less the entire northern hemisphere. Thus Dr. Hull shows that he belongs to those who regard purely terrestrial factors as the cause of the Glacial Period, in contrast to those who explain it on an astronomical basis. The book is useful to all who are interested in physical geography, whether they can agree with Dr. Hull's conclusions or not.

OUR BOOKSHELF.

The Elements of Statistical Method. By Willford I. King. Pp. xvii+250. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 6*s.* 6*d.* net.

IN this volume Mr. King has endeavoured "to furnish a simple text in statistical method for the benefit of those students, economists, administrative officials, writers, or other members of the educated public who desire a general knowledge of the more elementary processes involved in the scientific study, analysis, and use of large masses of statistical data." After a brief historical introduction, he outlines the uses and sources of statistical data, and then gives a few short chapters on "the gathering of material"; the third part, forming the bulk of the book, deals with "analysis," *i.e.*, tabulation, averages, dispersion, correlation, and so forth.

The writing of a satisfactory elementary work on such a subject—a work that can be placed in the hands of the junior student with confidence that he will not have to unlearn at a later stage some of the notions that he has gathered—is an exceedingly difficult feat, much more difficult in many respects than the writing of a work for more advanced students, and we cannot say that, in our opinion, Mr. King has altogether succeeded. The style is simple enough, but some matters are very insufficiently explained—probable errors, for example—and in other cases, notably in the chapters dealing with correlation, extensive revision and correction are required. A coefficient "of concurrent deviations" suggested on p. 208 does not fulfil the fundamental condition of becoming equal to zero if the deviations are independent. The student, in dealing with correlation, is repeatedly told to divide deviations by the mean, and the graph of regression obtained when the deviations have been divided by their respective means is termed the "Galton graph." What Sir Francis Galton did was to divide deviations by their respective quartile deviations—not their means—and he obtained the correlation coefficient graphically in that way. The relation of regression to correlation is never clearly exhibited, and Mr. King's use of the term is not in accordance with general usage. As it at present stands, the book cannot be recommended as a completely trustworthy guide.

Anthropologie Anatomique. Crâne—Face—Tête sur le Vivant. By Dr. Georges Paul-Boncour. Pp. xix+396. (Paris: Octave Doin et Fils, 1912.) Price 5 francs. (Encyclopédie Scientifique.)

THE enterprising publishers of the "Encyclopédie Scientifique" have arranged for the issue of a series of forty-eight volumes dealing with anthropology, the editorship of the series being assigned to Prof. Papillault, of l' cole d'Anthropologie, Paris. This volume, by Dr. Georges Paul-Boncour, forms the first of the series, and if its successors maintain an equally high standard, the "Bibliothèque d'Anthropologie" is destined to become a standard work.

Dr. Paul-Boncour's task is limited to a systematic study of the cranium, the facial part of the cranium, and the head of the living; his volume gives an accurate reflection of the methods and conclusions of the French school of anthropologists. The nature of his book is best indicated by a bare recitation of the subject-matter of its chapters.

The volume commences with a discussion on the growth and evolution of the skull, and then passes on to a description of its various parts. The succeeding chapters are devoted to the formation of the cranial cavity, to the methods of measurement and estimation of indices and of angles. The mandible and brain cavity are the subject-matter of special chapters. The second part—the more valuable—is devoted to the methods employed in registering the racial and individual characters as seen in living people—the form of the head, the development of muscles, the colour of the skin, the shape of the eyes, contour of the nose, form of ear, mouth, hair, and chin.

Dr. Paul-Boncour's volume is a simple, explicit, and methodical presentment of methods and opinions which have been perfected by the three generations of men who have made Paris the Mecca of anthropologists.

Science of the Sea. Edited by Dr. G. Herbert Fowler. Pp. xviii+452. (London: John Murray, 1912.) Price 6*s*. net.

THERE is a large though scattered body of people interested in oceanography or fascinated by marine biology, but prevented from making any advance by the want of practical direction and assistance: not only explorers and yachtsmen, but officers in the Navy with time on their hands in port or in foreign stations, medical officers on board ship or on coastal stations, and gentlemen who have retired from active service. To all such who wish to learn the methods of oceanographic inquiry, this book will be gladly welcomed, for it brings together instructions that otherwise are hard to find, given with the greatest care, and tested by the practical experience of many lives. The handbook is, in fact, the collective wisdom of the most active members of the Challenger Society, a body that has met quarterly in an unobtrusive fashion in London for some years, and now expresses its interest in oceanographic research by this publication.

The book begins with a chapter on meteorology by Dr. Mill and Capt. Wilson Barker, whose names, like those of the succeeding contributors, are guarantees of soundness and fulness of knowledge, and then proceeds to a well-illustrated account of hydrography, the joint work of Prof. H. N. Dickson and Mr. D. J. Matthews, of Plymouth. A very interesting and practically helpful account of tropical shore-collecting and outfit is given by Prof. Stanley Gardiner, whose methods, with a little adaptation, are applicable to similar work in temperate seas. Then follow four chapters on marine biology, including one by Sir John Murray on oceanic deposits and the organisms of the sea-floor. Fishing, whaling, and sealing are referred to in a rather summary fashion. Finally, the editor gives valuable counsel on methods of note-taking, whilst yacht-equipment, dredging, trawling, and the preservation of specimens are dealt with in a most helpful manner by the Director of the Marine Biological Association and others.

We congratulate the editor, Dr. Fowler, on the manner in which he has correlated and brought together such a valuable elementary compendium, and we can recommend this handbook as a trustworthy and practical guide to travellers, and not less a book of great interest to all biologists.

F. W. G.

LETTERS TO THE EDITOR.

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Practical Mathematics.

I WAS particularly sorry to be absent from the meetings of the International Mathematical Congress at Cambridge, because an address was expected from me upon the teaching of practical mathematics, and because Sir Wm. White, in his address on the relation of mathematics to engineering practice, referred to practical mathematics in a most contemptuous way.

Twenty years ago mathematics continued to be taught in what may be called the orthodox way, a way that succeeded fairly well with students who were fond of abstract reasoning, 3 per cent. of all students, and quite failed with the other 97 per cent. At the British Association discussion of 1901 (verbatim report published by Messrs. Macmillan), most of the great mathematicians and teachers of mathematics spoke or sent remarks in writing. In opening that discussion, I published my proposed Science and Art Department syllabus on practical mathematics. There was essential agreement with my views; there was scarcely one dissentient remark. A committee was formed, and recommended methods of teaching which are now extensively adopted. It is perhaps a pity that I gave such a misleading name as practical mathematics to the reformed methods, but I wanted to differentiate them from the orthodox methods of twenty years ago, and I did not dream that the new methods would be adopted so quickly. They are in use now in all the public schools where natural science is taught; they are in use in all science colleges and in all engineering colleges.

In evening schools it used to be that when a class of thirty apprentices was started in elementary mathematics, the attendance dwindled to ten in November, and in May it was usual to find only one or two faithful students. Now, in such schools, there is almost no teaching of the kind we used to call orthodox, but some hundred thousand apprentices study practical mathematics. The class of thirty formed in September remains in good attendance all the winter, and remains an excited and interested class of thirty in May. The new method suits the boy of great mathematical promise, but it is really arranged to give the average boy a love for computation and the power to use mathematical reasoning with pleasure and certainty. It recognises that every boy, every man, already possesses the fundamental notion of the infinitesimal calculus, and that it is quite easy to develop this notion so that he can use the methods of the calculus in his reasoning and computation. The subject was first recognised by the Science and Art Department in 1899; the number of students has increased year by year by the compound interest law, and it is now the most important science subject of the Board of Education.

When I was appointed professor of mathematics and mechanics, seventeen years ago, at the Royal College of Science, it was known that I would adopt that experimental method of teaching mechanics and applied mechanics and engineering science with which my name had become identified at the Finsbury College of the City Guilds. It is the method now in use in nearly all polytechnics and engineering colleges. It went hand in hand with the practical mathematics which it was also understood that I should establish at Kensington. My books describing these methods have been translated into many languages, and the methods have been largely adopted in America, Germany, and other foreign countries. Much of my time has been spent in showing foreign visitors how my methods of teaching were carried out in practice.

I feel sure that few of the men listening to Sir Wm. White, even of the foreigners, were ignorant of these facts. It is known that the most elementary class at the college, attendance at which is compulsory on all students of the Royal School of Mines and the chemical and other students, was taught on the lines laid down for all evening classes in practical mathematics, the work being made interesting for the average student, and including the elementary methods of the calculus. Not only here, but in the very highest mathematical work of the college, a competent person will see that the study is exceedingly different from what used to be the study of the mere mathematician on the same subjects. All our syllabuses and methods of teaching have been highly praised by most eminent judges, like the late Lord Kelvin, and they are now in no way different from what they were seventeen years ago.

According to the report in *The Times*, Sir Wm. White said that in the teaching of engineering students, some authorities now favoured special courses in practical mathematics; others believed that engineers should be taught by professional mathematicians because this method must lead to broader views and greater capacity for original investigation. His experience led him to rank himself with the supporters of the latter, and he said that this view is now adopted at the Imperial College of Science and Technology.

I know that Sir William contemplates great changes at the Imperial College, and no doubt great changes will rapidly take place, as I have been asked to retire, and Prof. Henrici has already retired. An attempt will, no doubt, be made to give up those methods to which I gave the misleading name practical mathematics, and in all probability the places of Prof. Henrici and myself will be taken by more orthodox persons. It is also probable that a "professional mathematician" will be put in charge of the teaching of mechanics. As I am still on the staff of the college I do not think that I can criticise the actions of the governing body. It is, however, my duty to deny a hurtful statement about my own department, and to oppose what I consider to be a wrong opinion, expressed at a public meeting by one of the forty members of the governing body.

I wish to observe that no change has yet been made. The syllabus and methods of teaching are exactly as they have been for seventeen years, and when Sir William says that his view is now adopted at the Imperial College he really means that he himself has adopted this view.

This is a most important matter. Sir William White's remarks may influence the action of the governing bodies of the other engineering colleges of the country. In England, if a man is a great lawyer it is assumed that his views about Tibet must be right; if he is a great chemist it is held that his views about women's suffrage must not be disputed; and if he is a great designer of ships it is assumed that he is an authority on technical education.

It used to be that colleges were governed by a council of the professors, but now the opinions of the professors are of no account, and the staff dare not even suggest to the governors that it is possible for honest, sensible, diligent, self-sacrificing shopkeepers, merchants, and manufacturers to be so misled that they may ruin technical education for the next ten years. Such ruin will only be temporary, it is true, but when I think of our competition with the foreigner I look with great dismay on the possibility that Sir William White's opinions may have too much weight with the persons who have charge of technical education.

The old engineering college did not compel its students to have more than the most elementary mathematical knowledge, because only civil engineering was taught, and the average civil engineer needs no mathematics. When mechanical engineering and shipbuilding students began to be taught, the mathematics standard was only slightly raised. But modern high-speed machinery has made it necessary for mechanical engineers to understand the effects of vibration, critical speeds of shafts, &c., and to pursue numerous studies which require a knowledge of higher mathematics even in the average student. And nowadays we have the electrical engineer requiring a knowledge of the methods of very advanced mathematics. Sir Wm. White thinks of the requirements of the civil engineer or shipbuilder of his youth; we teachers have to think of the requirements of the student of to-day. Now I affirm that the average student cannot be taught this necessary advanced work unless by the reformed methods. He cannot be carried beyond the most elementary things, and these he does not understand.

I have now expressed my opinion in regard to Sir William's remark about practical mathematics. In weighing our opinions it must be remembered that Sir William's practical experience as an engineer has been in naval architecture only, and as a teacher it lay also in naval architecture only, and a considerable time ago.

Sir William says that all the mathematical teaching of engineers should be by what he calls professional mathematicians, and he evidently means by this that these teachers shall not be engineers or men acquainted with engineering science. He means that they shall be mere mathematicians. Well, this has been tried often enough, and it has always been found that the one or two good students take a distaste to practical engineering, and the average student is never brought beyond the driest elementary work, and he hates the appearance of a mathematical symbol all his life after. The average student cannot understand abstract reasoning; his teacher has no knowledge of him, and pursues his serenely ignorant way, wondering how it is that so many students are stupid, or else he wonders that he and a few other men should be so supremely clever. He never studies his pupil. There are men who can train almost any animal; they study its habits of thought; they are kind and sympathetic. The poor average English boy is never studied by the professional mathematician.

JOHN PERRY.

Imperial College of Science and Technology,
September 2.

Polymorphism in a Group of Mimetic Butterflies of the Ethiopian Nymphaline Genus Pseudacræa.

A LITTLE more than two years ago Dr. Karl Jordan informed me that he had been studying the male genital armature of the Pseudacræas, and that he could not find any difference between the "species" of a large group made up of Linné's *eurytus* and its numerous allies on the west coast, of Neave's *hobleyi, terra,* and *obscura* in Uganda, of Trimen's *rogersi* of the Mombasa district and his *imitator* of Natal. All these forms possess patterns mimetic of species of the Acræine genus Planema. The conclusion was a very startling one. If each mimetic Pseudacræa had been confined to a single area and had interbred on its margin with the Pseudacrææ of surrounding areas with different mimetic patterns, we should have been confronted with a more remarkable and complex example than any as yet known (except perhaps *Papilio dardanus*), but one that raised no special difficulty. Dr. Jordan's discovery, however, involved far more than this: it led to the remarkable conclusion that the sexually dimorphic *P. hobleyi,* mimicking the sexually dimorphic *Planema macarista* in the Entebbe district, was the same species as the two monomorphic Pseudacræas flying in the same forests with it, viz. *P. terra* and *P. obscura*, mimicking respectively the sexually monomorphic *Planema tellus* and *P. paragea.*

Dr. Jordan communicated his discovery to the First International Entomological Congress, meeting at Brussels in 1910, and at the same meeting I brought forward the results of researches in 1909 by Mr. C. A. Wiggins, D.P.M.O. of the Uganda Protectorate, upon the Pseudacræas and other mimetic butterflies of the forests near Entebbe. The preparation of this latter paper afforded the opportunity of testing Dr. Jordan's conclusions by the careful study of a splendid mass of material.

Out of the long series of Pseudacræas, two specimens yielded strong support: (1) a male *P. terra* with a pattern approaching the male of *P. hobleyi*; (2) a female *P. hobleyi* bearing the mimetic colours of its own male. Nevertheless, I felt, and stated in the paper published in the Proceedings of the Congress, that conclusions so far-reaching ought not to be finally accepted until they had been tested by breeding.

Mr. Wiggins has continued his fruitful study of mimicry in the forest butterflies of Uganda from the point reached in the Brussels paper up to the present time.

There was, however, a break in 1911, when he came home and worked with me upon his material in the Oxford museum, preparing a tabular statement for the Second International Congress which has just met at Oxford. The results which have been gained from his enthusiasm and energy will throw far more light on the proportions of mimics and models at different seasons and in different years than has been shed by any other naturalist in any part of the world. A few more intermediate Pseudacræas, and one or two more male-coloured females of *P. hobleyi,* appeared in the wonderful series obtained by him, but the collection as a whole shows that in the forests within a few miles of Entebbe two out of these three mimetic Pseudacræas, viz. *hobleyi* and *terra,* are wonderfully constant and sharply marked off, and that the sexual dimorphism of one of them is nearly always pronounced. In the Entebbe district the third form, *P. obscura,* is so much rarer than the others that it is at present impossible to speak with any certainty of its constancy.

While Mr. Wiggins was continuing his researches on the mainland, Dr. G. D. H. Carpenter, a member of the Royal Society's Sleeping Sickness Commission, began to study Pseudacræas in the intervals of his work on the tsetse-flies of the islands in the north-west of the Victoria Nyanza. During a large part of 1911 Dr. Carpenter was on Damba Island, on the Equator, about twenty miles south-east of Entebbe. Early in the present year he moved to Bugalla, one of the Sesse islands, to the south-west of Damba. In both these islands he found the Planema models rare as compared with their mimics. The Planemas are apparently more exclusively forest butterflies than the Pseudacræas, and the forested areas on the islands may not be extensive enough for them to establish themselves freely. Furthermore, the proportions of the three forms of Pseudacræas are very different.

On the adjacent mainland *hobleyi* is by far the commonest form, and *obscura* much the rarest. Although on the islands the exact proportions have not been ascertained, it is clear that *terra* is by far the commonest, and *obscura* quite abundant. Male-coloured females of *hobleyi* are rare, although apparently less rare than in the Entebbe district; but the chief interest of the island Pseudacræas lies in the extraordinary number of transitional forms—between *terra* and *obscura,* between *terra* and the female *hobleyi,* between *terra* and the male *hobleyi,* between *obscura* and the female *hobleyi.* Dr. Carpenter has also observed on Bugalla the male of *hobleyi* pursuing the female of *terra,* the male of *terra* the female of *hobleyi,* and the male of *obscura* the female of *terra.*

All these facts offer the most convincing support to Dr. Jordan's conclusions, as well as to an interpretation of mimicry based on natural selection. Where the models—which are different species sharply cut off from one another—are predominant the mimetic forms of an interbreeding community are also sharply cut off, and intermediates are rare; where the models —although all of them exist—are in a small minority, the forms of the mimetic community tend to run into one another. The results here summed up were communicated to the Entomological Society, and will be found in the Proceedings for 1911 (pp. xci.–xcv.) and 1912 (pp. xix.–xxiii., and later pages as yet unpublished).

Finally, my friends Mr. Guy A. K. Marshall, scientific secretary of the Entomological Research Committee of the Colonial Office, and Mr. S. A. Neave have given me the opportunity of studying the collections made in 1911–12 by the latter over a wide area in the Uganda Protectorate —from the Mount Elgon district far to the north-east of Entebbe, to Buddu in the south, and Ankole, Unyoro, and Toro, as far as Ruwenzori and the Semliki Valley, to the west. As yet only a few of the specimens have been "set," so that it has been impossible to study the patterns in detail, but one important conclusion has emerged, viz. that male-coloured females of *P. hobleyi* were relatively far commoner outside the Entebbe district than we know them to be within it. The most remarkable manifestation of this tendency was encountered (August 13, 1911) on the Siroko River (3600 ft.), near the western foot of Mount Elgon, when Mr. Neave collected ten males of *P. hobleyi,* eight male-coloured females, and four normal females. This change in the proportion of the females corresponds with a change in that of the models, *Planema poggei,* with both sexes resembling the male of *P. macarista,* being commoner and *P. macarista* rarer outside than they are within the Entebbe district, so well investigated by Mr. C. A. Wiggins. Mr. Neave never saw the latter species near Mount Elgon, in Kavirondo, or indeed anywhere to the east of the Nile at Jinja.

We now come to the evidence furnished by breeding, which indeed is the object of the present letter. Ever since the Brussels Congress I have tried to induce

African naturalists to settle this question. In Natal Mr. G. F. Leigh, the late Mr. A. D. Millar, and Miss Fountaine have been successful in breeding the two Pseudacræas, *lucretia* and *imitator*, but the latter, which is the only Natal member of Dr. Jordan's group, appears in a single form mimetic of *Planema aganice*, and is therefore incapable of supplying the desired test. I attempted to induce both Miss Fountaine and Mr. Millar to travel to Entebbe in order to decide the question. My friend Mr. W. A. Lamborn, who has done such splendid work in breeding Lepidoptera in the Lagos district, has reared *P. lucretia* and also *P. semire*—the latter, I believe, for the first time—but has not yet been successful in finding the larvæ or in obtaining the eggs of any local form of *P. eurytus*.

Lately, however, I have felt confident that success would be achieved by Dr. Carpenter, with his wide experience of breeding and residence in an exceptionally favourable locality. He first succeeded in finding and rearing the larvæ of *P. lucretia*, and then made many attempts to obtain eggs from captured females of the *hobleyi* group. Discouraged by many failures, he was beginning to despair when, some weeks past, he observed in the Bugalla forest a female *obscura* "with a touch of *hobleyi*" settling in an unusual position on a leaf of the food-plant of *lucretia*—almost certainly a Sapotaceous plant. The butterfly escaped, but Dr. Carpenter found the egg on the leaf, and hoped to rear the perfect insect before or during the meeting of the Second International Congress at Oxford (August 5–10), and he promised that if the offspring turned out to be *terra* or *hobleyi*, he would cable the result. He wrote that he anticipated *terra*, because this form is much the commonest on Bugalla.

Unfortunately the eagerly-expected butterfly did not emerge until after the meeting, but on August 19 I received a cable from Entebbe with the word "terra." Furthermore, Dr. Carpenter has now succeeded in obtaining eggs laid by known parents upon enclosed branches of the food-plant in the forest, so that we shall not have to wait long for evidence that is tolerably certain to afford direct proof of Dr. Jordan's conclusions as regards all the forms of the *hobleyi* group on the island, and is likely to establish the genetic relationship between them.

Dr. Jordan, Mr. Wiggins, Mr. Neave, and Dr. Carpenter are all to be warmly congratulated on the parts they have played in solving a bionomic problem of extraordinary interest and complexity.

E. B. Poulton.

St. Helens, Isle of Wight, August 28.

Wireless Telegraphy and Terrestrial Magnetism.

The report in *The Times* of the discussion on wireless telegraphy at the British Association meeting in Dundee mentions the hypothesis—introduced apparently by Dr. Eccles—that several of the phenomena of the propagation of electric waves round the earth are largely influenced by the existence of an ionised layer in the atmosphere. The hypothesis seems analogous to, if not identical with, one made by several magneticians independently, with the object of explaining phenomena exhibited by the diurnal variation of the magnetic elements. This diurnal variation is now generally regarded as most probably due to electric currents in the upper atmosphere, and it has been suggested that the fact that the magnetic changes are normally larger by day than by night is due to an increased ionisation of the atmosphere due to sunshine.

The regular diurnal magnetic variations are much larger in years of many than of few sun-spots. The difference between the size of the day and night movements is relatively reduced in years of sun-spot maximum, and in all years during large magnetic storms. Again, the diurnal variation is much larger in high latitudes—where aurora abounds—than elsewhere, and the difference between day and night phenomena is there much reduced. Finally, it has been recently found that a substantial part of the magnetic sun-spot relationship may be explained by a direct connection between the amplitude of the diurnal magnetic range and the spotted area of the sun some four days previously. These phenomena, or at least some of them, have been ascribed to corresponding changes in the ionisation of the upper atmosphere.

The natural inference, in short, is that the ionisation is much enhanced in years of sun-spot maximum and during magnetic storms, and is substantially influenced by the sun-spot area four days previously. Also one would infer that in high latitudes the upper atmosphere is normally much more highly ionised than elsewhere. If wireless telegraphy is largely dependent on an ionised layer, then unless this layer is distinct from that which influences terrestrial magnetism, we should expect wireless phenomena to show peculiarities corresponding to those just described in terrestrial magnetism. My object in writing this note is to direct the attention of those in control of wireless installations to the field of research which is thus suggested. Wireless telegraphy may yet lend itself to the direct experimental investigation of the causes of a variety of the phenomena of terrestrial magnetism.

September 7. C. Chree.

On the Structure of the Stromatoporoid Skeleton, and on Eozoon.

I have pointed out (Annals. Mag. Nat. Hist., September, 1912) that Stromatoporoids are Foraminifera, but I did not give an explanation of the structure of the skeleton. I now find that the clue to this structure lies in the "astrorhizæ" or stellate patterns on the surface of many of these fossils.

Each astrorhiza consists of a spiral series of chambers formed round a central and a circumambient chamber, and the existence of a number of astrorhizæ is due to budding—as in corals. Anyone who has been bewildered—as I have been—at the apparent complexity of Stromatoporoid structure will at once appreciate—I cannot forbear saying—the beautiful simplicity of this solution of a difficult problem, and will realise that these organisms have at last come to rest in their proper place. I am publishing in the October number of the Annals a revised classification of the group.

Eozoon canadense likewise is a colony-forming Foraminiferan, the unit in this case being a coiled Nummulitid shell. Convincing evidence for this statement also will be given in the October number of the Annals Mag. Nat. Hist.

In view of a possible recrudescence of the Eozoon controversy, it is very fortunate that the evidence in favour of the theory of organic origin is now so overwhelming that the former opponents of that theory will readily change their views. R. Kirkpatrick.

British Museum (Nat. Hist.).

The Striation of Stones in Boulder Clay.

In Nature of September 5, Dr. A. Irving, in criticism of statements by Mr. Reid Moir, asks "how could the soft matrix of the Boulder Clay scratch a flint, or even hold a harder stone with sufficient grip to give it effect as a graving-tool?"

It is true that one may see flints emerging from arctic glaciers unscratched and unrounded, while softer rocks are reduced to strongly striated boulders; but Dr. Irving seems to conceive the Boulder Clay as something distinct from the ice-sheet in which it originated, and as merely pressed on by superincumbent ice. It cannot be too strongly urged that the lower portions of glaciers of the continental or ice-sheet type consist largely of stones and mud and abrading sand-grains, and that these materials are held in the grip of the ice and are moved against one another as it flows. The ice-sheet is, in fact, a conglomerate with an ice cement; the Boulder Clay is an essential part of it, and remains as its representative when the portion that can melt has yielded before climatic change. GRENVILLE A. J. COLE.

Royal College of Science, Dublin, September 6.

Boulder Clay in Essex.

YOUR correspondent Dr. Irving, in his letter entitled "Boulder Clay in Essex" (NATURE, August 22), states that he has made a keen but futile search for a human artefact in the Boulder Clay, and, I presume, infers that these relics do not occur therein.

I have had no opportunity of carefully examining the Boulder Clay of Essex, but for the last six years I have been able to search that of Suffolk, and know that the occurrence of humanly flaked flints in this latter deposit is capable of unassailable demonstration. As until the notification of a human skeleton having been found beneath the Boulder Clay no search had been made in the clay for worked flints, and as that notification was made only a few months ago, I think that perhaps further and more prolonged search in the Essex deposits will reveal some of the type of implements which are found in Suffolk.

But even if this is not so, it cannot be brought as an argument against man's presence here before the deposition of the Boulder Clay. It would be as foolish to argue that because palæolithic implements are not found in a certain section of river-gravel, they do not occur in any other portion of the same deposit.

J. REID MOIR.

12 St. Edmund's Road, Ipswich.

The "Titanic."

YOUR article (NATURE, August 29, 1912) on the report of the Advisory Committee having emphasised the contention from the first of some of us (students of science and old naval commanders) as to the insanity of high speed "at night in the known vicinity of ice," it behoves surely men of science to ask the question whether we have not reached the imperative limits of that false security which the "practical man" is wont to feel in his contempt for scientific "theory"; and, further, whether the time has not therefore come for legislation requiring commanders of the largest ocean-going steamers to hold a diploma, guaranteeing such a systematic course of study (say in a class at Greenwich or Kensington) in marine physiography and the elementary laws of mechanics as would quicken their imagination as to the uncertainty and the magnitude of the risks to be run in an abnormally ice-drifted sea. Lord Mersey's report may whitewash the facts, but the facts *en évidence* remain; and the chain of cause and effect in the lamentable and tragic loss of the *Titanic* leads us in the last resort to the notorious contempt for scientific acquaintance with the facts and laws of nature on the part of the "practical man." A. IRVING.

Hockerill, Bishop's Stortford, September 2.

STUDIES OF AURORA.[1]

ONE or two photographs of aurora seem to have been taken before, but Prof. Störmer is the first to meet with marked success. In the earlier of the volumes before us he describes with full detail the apparatus and methods employed in photographing aurora during a stay of some months at Bossekop, in the extreme north of Norway, early in 1910. Photographs were taken by Störmer and an assistant from the two ends of a base of about $4\frac{1}{4}$ kilometres, simultaneity of exposure being secured by telephonic signal. Using special plates, satisfactory photographs were obtained with a few seconds' exposure. One or more prominent stars were always included in the photograph, and the time was carefully noted. From the known coordinates of the stars, it was thus possible to fix the position of the aurora. The base was long enough in general to give a parallax which could be measured with sufficient accuracy to determine the approximate position and height of selected prominent points. The heights calculated for the different auroras varied from 36 to 461 kilometres. Fig. 1 shows a photograph—from the original

FIG. 1.—Reproduction of a photograph of an aurora: original size.

negative—taken with 3 seconds' exposure; Fig. 2 is an enlargement, the original of which had a 5 seconds' exposure.

The second of the two volumes referred to below repeats some of the information given in the first, but is mainly theoretical. Störmer was apparently first attracted to the subject of aurora and magnetic storms by the work of his well-known colleague at Christiania, Prof. Kr. Birkeland, but the views he now holds are independent.

An electrified particle projected in a uniform magnetic field H describes with uniform velocity a helix about the lines of magnetic force. If projected perpendicular to the lines of force, it describes a circle of radius ρ. If m be the mass, e the charge, v the velocity of the particle, and V the velocity of light, then, according to Störmer, $H\rho=(m/e)v(1-v^2/V^2)^{-\frac{1}{2}}$. This differs from the usual formula in English books unless $(v/V)^2$ be

[1] "Bericht über eine Expedition nach Bossekop zwecks photographischer Aufnahmen und Höhenmessungen von Nordlichtern. By Carl Störmer. (Utgit for Fridtjof Nansens Fond.) Pp. 112+88 plates. (Kristiania: Jacob Dybwad, 1911.) Extract from Videnskap. Skrift. Mat. Natur. Klasse, 1911

"Sur les Trajectoires des Corpuscles électrisés dans l'espace sous l'action du Magnétisme Terrestre avec application aux Aurores boréales (second Mémoire). By Carl Störmer. Pp. 163+10 plates. Extrait des Archives des Sciences physiques et naturelles, Geneva, 1912.

negligible, which is far from the case in some of the hypothetical cases dealt with by Störmer. $H\rho$ may for mathematical purposes be regarded as the characteristic constant for a definite species of ray.

In his earliest work, Störmer treated the earth as a uniformly magnetised sphere, of moment $8{\cdot}52 \times 10^{25}$ C.G.S. Assigning to $H\rho$ values ordinarily conceded to kathode rays and β-rays of radium, he found that no electrified particle coming from the sun could reach the earth's atmosphere except in the immediate vicinity of a magnetic pole. If, for instance, $H\rho$ is 1000, the greatest angular distance from the pole is only $3{\cdot}8°$, and to increase the angle to $22°$—which answers roughly to the position of maximum aurora—one must assign to $H\rho$ the enormous value 10^6. To account for the observed occurrence of aurora in low latitudes, Prof. Birkeland has had to assume no less a value than 7×10^6, which implies a very close approach in v to the velocity of light.

Prof. Störmer sets out in quest of another explanation. His first idea was to substitute for the field of a uniformly magnetised sphere that derived from the earth's Gaussian potential, based ultimately on the work of Carlheim Gyllensköld. The mathematical difficulties were thereby much increased, while the physical difficulties showed no abatement. Störmer's next idea was suggested apparently by experiments of Birkeland's, which showed that kathode rays in a vacuum tube containing a magnetised sphere can form a luminous ring in the magnetic equator. Störmer supposes a gigantic ring of kathode rays to form and persist for some time in the plane of the earth's magnetic equator, and the auxiliary magnetic field thus produced is believed to render access to low latitudes possible to other kathode rays coming from the sun.

In the absence of a ring, as already remarked, rays require $H\rho$ to equal 10^6 to permit of their getting as far as $22°$ from the magnetic pole, but this becomes possible to rays the $H\rho$ of which is only 1000, provided there is an equatorial ring of 140 times the earth's radius, carrying a current of about 60 million amperes. The rays forming the ring are supposed to be quite distinct. Their value of $H\rho$ increases from 100 when the ring's radius is 1400 times the earth's to 10^6 when the former radius is 14 times the latter. For a given size of ring, the distance from the magnetic pole which rays coming from the sun can attain increases with the current in the ring. In the case of the largest angular distance considered in detail, $41{\cdot}6°$, the rays forming the ring and those coming from the sun have both 10^6 for their value of $H\rho$, and the

FIG. 2.—Enlargement of a photograph of an aurora on February 28, 1910.

current required in the ring is 100 million amperes. The magnetic field due to this current at the earth's surface is given as 681γ, which represents a magnetic storm of the first order.

In considering how the question is affected by the presence of the earth's atmosphere, Störmer inclines to the views of Wegener (while not committing himself to the existence of a gas, "geocoronium," of one-fifth the density of hydrogen). At altitudes above 100 kilometres there is supposed to be no trace of anything but the lighter gases, especially hydrogen (and geocoronium, if it exists). In agreement with Lenard, Störmer concludes that ordinary kathode rays coming from space would be absorbed in the upper hydrogen atmosphere before reaching the 100 kilometres level, that β-rays of radium would be absorbed in the nitrogen atmosphere at heights of 50 to 70 kilometres—a common altitude for the lower border of auroral "curtains"—and that the rays forming the lowest aurora he has measured must have a greater penetration than β-rays. Fairly substantial evidence has been advanced by Paulsen and others that auroras in the auroral belt, especially in Greenland, sometimes come much below the lowest height, 36 kilometres, observed by Störmer at Bossekop. This tends to support Birkeland's latest views as to an enormously high velocity in the rays if they originate in the sun. On the other hand, there seems reason to accept Störmer's view that auroras seen in low latitudes are usually at considerably greater heights than those seen in the Arctic. Thus aurora in low latitudes would seem to arise from rays of less, not of higher, penetration than those in high latitudes, which seems inconsistent with Birkeland's hypothesis.

Störmer's mathematical work, like Birkeland's, assumes the motion of the individual corpuscle to be unaffected by the presence of other corpuscles. This is one of the principal criticisms urged by Prof. Schuster,[2] who concluded that the scattering inevitably produced is fatal to Birkeland's theory, so far at least as magnetic storms are concerned. The same criticism would seem to apply, with at least equal force, to Störmer's theory. It would thus be of great interest to have Prof. Störmer's views on the validity of Prof. Schuster's criticisms. Meantime, considering the calibre of the protagonists, the prudent course seems to be to "wait and see." But whatever the fate of Störmer's theoretical work may be, his photographs of aurora clearly constitute a fundamental advance towards exact knowledge. In temperate and southern Europe, aurora and large magnetic storms are both rare events, and their coincidence of occurrence seems the rule rather than the exception. A total absence of physical connection between the two phenomena seems thus almost inconceivable. The careful intercomparison of measurements of aurora—rendered possible by Störmer's work with contemporaneous records from magnetic observatories is clearly one of the most promising methods of getting at the root of the matter.

C. CHREE.

[2] Roy. Soc. Proc., A. 85, 1911, p. 44.

PROF. THOMAS WINTER.

PROF. THOMAS WINTER, of the University College of North Wales, Bangor, whose death we recorded in our last issue, was the son of Mr. Thomas Winter, of Lotherton Park, Aberford, Leeds. Born in 1866, he was educated at the Darlington Grammar School under Dr. Wood, and afterwards proceeded to the University of Edinburgh, where in 1888 he graduated in arts with honours in natural science. On leaving the University he became a master at a Scarborough school, and later at the Norfolk County School at Dereham. The son of a successful practical farmer, and equipped with a university training in natural science, he was naturally attracted to the development of schools of agriculture in the provincial colleges and universities which marked the later decades of the last century. In 1891 he was appointed assistant lecturer in agriculture at the University College of North Wales, Bangor. In 1892 he accepted a similar appointment at the Yorkshire College, Leeds, as it then was, but returned in 1894 to Bangor as head of the department of agriculture, a post which he occupied for the next eighteen years. It is thus in North Wales that his life-work chiefly lay, and where the stimulus which he gave to the cause of agricultural education will be longest felt.

The work of a school of agriculture has its internal and external sides. On the internal side courses of instruction have to be provided with a view to certificates, diplomas, and degrees. On the external side the agricultural community within the area served by the school has to be considered, and extension lectures, field experiments, and instruction in dairy-work have to be provided for the benefit of those who cannot reach the college. In both these aspects of the work of his chair, Prof. Winter achieved a rare success. Within the University of Wales his sound judgment contributed to the framing of the existing scheme of instruction for the degree in agriculture and rural economy, the marked feature of which is the requisition of an adequate acquaintance with the pure sciences, prior to the study of their applications to agriculture. It was also to Prof. Winter's fostering care that the chair of forestry was established at Bangor.

In the external work of the department his gift of organisation and his tact and good sense have greatly contributed to the removal of the distrust of agricultural education among old-fashioned farmers. Not the least contribution to this end was his successful management of a college farm, where experiments in cropping and breeding have been carried out, and where the visits of farmers and their sons and daughters have always been welcomed. Prof. Winter's death while still in the prime of life will be greatly deplored by his colleagues on the senates of his college and university, by his former pupils scattered in many parts of the world, and not least among the farmers of the North Welsh counties.

THE BRITISH ASSOCIATION AT DUNDEE.

IT is often pointed out that the meetings of the British Association can never be so important in the future in the estimation of the public as they were in the past. First, because there used to be only one yearly congress attracting general attention; now there are many, and any such meeting is a great expense to a town. Secondly, the most important function of the meeting, the temporary creation of an interest in natural science, is less wanted, because everybody now takes an interest in science, and almost every city now visited has a science college where evening lectures are given. Thirdly, the disappearance of the pioneers of the Huxley type, whose names were well known outside scientific circles. Fourthly, the death of that interest which used to be excited by the quarrel between science and religion.

The Dundee meeting shows that the British Association excites as much interest, not merely among scientific men, but in the general public, as it has ever done in the past. In the hotels here there is still hanging a notice of some weeks ago referring to the expectation that the membership of this meeting may reach 1200 in number. As I write, the number is more than 2460, a number greater than that of the members of the Dundee meeting of forty-five years ago, which is often referred to as a great meeting.

There has been a little grumbling that there were some hundreds of members who could not get seats for the president's address and some of the evening lectures. Naturally, the local secretaries are blamed, but they have the valid excuse that nobody could have expected the meeting to be so successful as to numbers, and they were probably afraid that the hall provided might actually be too large. Much of the success of a British Association meeting is due to the recognition by the local authorities that some one man of great energy and knowledge and tact and good humour must devote himself to its organisation for eighteen months beforehand. Large subscriptions of money are wanted; enthusiasm must be created and maintained in an army of hard-working members of committees. Nobody denies that it is to Prof. D'Arcy Thompson that the enormous success of this meeting is due. Everybody knows the grumbling which in some irritable members is sometimes very loud, when they meet with slight inconveniences. Whether it is that the arrangements are more perfect than usual or that members are in better temper, I do not know, but there is certainly less than the usual amount of complaint.

Almost everybody expected the weather to be bad. Except that we had rather windy weather for a day, and some occasional threats of rain which came to nothing, the weather has been very good. The hotel accommodation is not great for so important a town, but there is much private hospitality, and on the whole the physical comforts of the visitors are better looked after than a person acquainted with Dundee could have anticipated.

At every meeting of the British Association it is found by the visitors that most of the good reserved seats for the presidential address are booked by local people before the first day of the meeting. It is probable that the pressure of the local desire for seats is always too great for the resistance of the local secretaries. The consequent heartburning has been greater than usual this year, because the number of members so largely exceeds all expectation.

The success of a meeting depends greatly on the attention paid to certain details some of which might seem unimportant. First, the reception room should be large, and should have such ample accommodation of many kinds that members, when there, shall feel almost as if they were in a club. It ought to be in a central position, as near as possible to the most frequented section. It is essential that the meetings of the council and general committee and the committee of recommendations should be held in some neighbouring place, if not in the same building. Secondly, there are now twelve sections, and meeting rooms must be provided for each of them, each with its committee room, and sometimes one section may split up into two or three. These rooms must all be large and conveniently arranged, because changes cannot be made near the time of the meeting, and any of the sections may turn out to be exceedingly popular, and be unexpectedly well attended. Thirdly, although there are many members who wish to attend only one section, and the Recorders try to keep papers of one particular kind of interest to one section, on any one day, a member always finds that there are papers interesting to him in two or more sections, and he desires to hear them.

It is therefore important to have facilities for getting rapidly from one section to another. I am now speaking of the scientific members. But besides these, the non-scientific people must be thought about, the people who divide their attention over all the sections, and who desire to hear as many interesting papers as possible on quite diverse subjects. It is evident that the best of all cities for a British Association meeting is one which can house all the twelve sections and reception room in one great building or in a few large buildings which are close together. But as this is generally impossible, the best compromise is to place the sections near one another in groups of allied subjects. It is evident that great attention has been paid to this most important idea at Dundee, and, considering the accommodation of the town, it is impossible to suggest a change for the better.

The sections for mathematics and physics, chemistry and engineering, are in the University College buildings, not too easily reached from the reception room, a fifteen minutes' walk or by infrequent tram-car; with these we have zoology and physiology. The College buildings are well away from the other groups. One other such group is of geology, botany, and agriculture;

another is geography and anthropology; another is economics and education, and, except the College group, they are all quite near the reception room. No matter what arrangements had been made, there must have been inconvenience for some members. It is now difficult for a man whose chief interest is in physiology to hear a botany paper, or for a man interested in mathematics or physics or chemistry to hear an education paper, but I have heard much less complaint about such matters than I have ever heard before at a British Association meeting.

The presidential address is usually rather a disappointment to a general audience, many of whom cannot hear, and the subject is often of only special interest to some scientific people. On this occasion the voice of the president was low but penetrating, and I never remember an occasion since the time of Tyndall when one felt so strongly that there was subdued but intense feeling in the audience. When at length the Lord Provost sprung upon the meeting the hitherto carefully hidden fact that Dr. Caird had made us a gift of 10,000*l.*, there was a thrill through the audience which made itself immediately manifest. Satisfaction and delight were to be expected on the faces of the visitors, but it might have been expected that Dundee people would not altogether like to see so large a benefaction leaving their town. But, as a matter of fact, the pride already felt by the local people in the acknowledged success of the meeting was augmented in a wonderful manner, and there was only delighted satisfaction in their faces and congratulation in their language. The feeling of the more permanent members of the association is soberly expressed in the remarks of the treasurer when he proposed the vote of thanks to Dr. Caird at the meeting of the general committee.

As for the scientific work, I can only speak as one member attending sections A and G. The presidents' addresses and the reading of papers have so far been well attended by mathematicians, physicists, and engineers, as well as by the ordinary members. A joint discussion between these sections on unsolved problems in wireless telegraphy was so well maintained and so interesting that when Lord Rayleigh was speaking, one thought at once of the possible return of the older times when Kelvin or Fitzgerald suddenly illuminated our proceedings. From men attending the other sections I have heard so far only of successful sectional meetings. There is no doubt that much more than the average number of members capable of speech and interested in the scientific work of the Association are present at this meeting of the British Association.

JOHN PERRY.

At the meeting of the general committee on Friday, September 6, it was unanimously resolved "That the best thanks of the British Association be expressed to Dr. J. K. Caird for his most generous gift to the Association." Speaking to the motion, Prof. Perry, the general treasurer, said:—"This is the only gift of money that the British Association has ever received. It is greatly needed. In my eight years of office as treasurer the nominal assets of our Association have neither increased nor diminished. I have made the fat years of our visits to large cities make up for the lean years of our visits to smaller towns. But although our nominal wealth is the same, our actual wealth is less because of the depreciation of Consols and our other investments.

"There are two great functions of the British Association. One is to stir up all the people of this Empire occasionally to take an interest in scientific discovery and research of all kinds; the other is less known. It is perhaps the treasurer of the British Association who knows better than anybody else the enormous importance of the work that is done every year by the committees appointed by the various sections to make scientific researches during the ensuing year.

"Groups of men of the highest scientific attainments and reputation give their time and enthusiasm to the work, and they only ask that quite a small part of their out-of-pocket expenses shall be paid. I know of no work in the world that is so important or that is so little known.

"Every year your treasurer meets the Committee of Recommendations, each section strong in its reason for getting money, and yet the aggregate amount asked for is so much above our means. It really goes to my heart every year to limit the supply of money, and my colleagues here, the secretaries, blame me every year because I give more money than I ought. I particularly feel for the biological committees. I know nothing of biology, but I know of the enormous importance of the work done by the biological committees; and these biological people can get no outside money. If I want money for any important scientific object relating to physics or engineering, I know at once where to apply for a few hundreds or even many hundreds of pounds, and I get it readily, for men have become rich through engineering. But the biological people seem to have no outside pecuniary resources. I am, however, glad to think that this gift is not earmarked in any way. It is generous and unconditional.

"Gentlemen, your treasurer assures you that this splendid gift of Dr. Caird will return him more interest than all the other benefactions."

At the same meeting of the general committee, Sir William White, K.C.B., F.R.S., was elected President for the meeting of the Association to be held at Birmingham next year from September 10 to September 17. The following have been appointed Vice-Presidents of this meeting:—The Right Hon. the Lord Mayor of Birmingham, the Lord Lieutenant of Warwickshire (the Most Hon. the Marquess of Northampton), the High Sheriff of Warwickshire, the Lord Lieutenant of Worcestershire (the Right Hon. the Earl of Coventry), the Lord Lieutenant of Staffordshire (the Right Hon. the Earl of Dartmouth, V.D.), the Right Rev. the Lord Bishop of Birmingham, the Chancellor of the University of Birmingham (the Right Hon. J. Chamberlain, M.P.), the Vice-Chancellor of the University of Birmingham, the Principal of the University of Birmingham (Sir Oliver Lodge, F.R.S.), the Hon. President of the Birmingham Chamber of Commerce (the Right Hon. Jesse Collings, M.P.), Alderman the Right Hon. William Henrick, J.P., the Deputy Lord Mayor of Birmingham, Prof. J. H. Poynting, F.R.S., Prof. C. Lapworth, F.R.S.

Local officers:—Treasurers, Alderman Sir G. H. Kenrick and Councillor Neville Chamberlain, J.P.; secretaries, Prof. F. W. Gamble, Mr. Howard Heaton, Mr. John Humphreys, and Mr. W. Byng Kenrick.

SECTION B.

CHEMISTRY.

Opening Address by Prof. A. Senier, Ph.D., M.D., D.Sc., President of the Section.

I am sure it will be agreeable to the feelings of the members of this section that, before beginning my address, I should refer to the great losses we have sustained by death since our gathering last year at Portsmouth.

An active member and past-president has passed away in the death of Edward Divers, after a serious operation, undergone at his advanced age with characteristic fortitude. His devotion of his long life, in this country and Japan, to the advancement and diffusion of science is indelibly inscribed in its records. But Divers was more than an investigator and teacher; he was a beloved centre of our social life, and was particularly happy when he could bridge over the distance between the young beginner in research and the older experienced master. He understood and had the sympathy of both.

In Henry Forbes Julian, one of the victims of the awful disaster to the *Titanic,* we have lost a valued contributor to our proceedings; though he was best known as a geologist and metallurgical engineer. It was, however, by chemistry, under the inspiring influence of Sir Henry Roscoe, that his first enthusiasm for science was aroused. Forbes Julian was a leading technical adviser in mining undertakings, and his advice was much sought after, especially in South Africa, and even in Germany.

Another tragedy, from the shock of which we have not yet recovered, has deprived science of the young and promising inquirer, Humphrey Owen Jones. We know the dreadful details—he and his young wife—how they became sacrifices to the treacherous crags and snows of Mont Blanc.

And this, alas, is not all. On the very day of the fatal accident to Humphrey Jones, another young and promising chemist—John Wade—passed from us from the effects of a cycling accident. He was an inquirer of singular ability, and found time also to give us one of our deservedly most popular manuals of organic chemistry.

Part I.

The Nature and Method of Chemistry.

Perhaps there is no intellectual occupation which demands more of the faculty of imagination than the pursuit of chemistry, and perhaps also there is none which responds more generously to the yearnings of the inquirer. It is surely no commonplace occurrence that in experimental laboratories day by day the mysterious recesses of Nature are disclosed and facts previously quite unknown are brought to light. The late Sir Michael Foster, in his presidential address at the Dover meeting, said:—"Nature is ever making signs to us, she is ever whispering the beginnings of her secrets." The facts disclosed may have general importance, and necessitate at once changes in the general body of theory; and happily, also, they may at once find useful application in the hands of the technologist. Recent examples are the discoveries in radio-activity, which have found an important place as an aid to medical and surgical diagnosis and as a method of treatment, and have also led to the necessity of our revising one of the fundamental doctrines of the theory of chemistry—the indivisibility of atoms. But the facts disclosed may not be general or even seem important; they may appear isolated and to have no appreciable bearing on theory or practice—our journals are crowded with such—but he would be a bold man who would venture to predict that the future will not find use for them in both respects. To be the recipient of the confidences of Nature; to realise in all their virgin freshness new facts recognised as positive additions to knowledge, is certainly a great and wonderful privilege, one capable of inspiring enthusiasm as few other things can.

While the method of discovery in chemistry may be described, generally, as inductive, still all the modes of inference which have come down to us from Aristotle, analogical, inductive and deductive, are freely made use of. A hypothesis is framed which is then tested, directly or indirectly, by observation and experiment. All the skill, all the resource the inquirer can command, is brought into his service; his work must be accurate; and with unqualified devotion to truth he abides by the result, and the hypothesis is established, and becomes part of the theory of science, or is rejected or modified. In framing or modifying hypotheses imagination is indispensable. It may be that the power of imagination is necessarily limited by what is previously in experience—that imagination cannot transcend experience; but it does not follow, therefore, that it cannot construct hypotheses capable of leading research. I take it that what imagination actually does is—it rearranges experience and puts it into new relations, and with each successive discovery it gains in material for this process. In this respect the framing of a hypothesis is like experimenting, wherein the operator brings matter and energy already existing in Nature into new relations, new circumstances, with the object of getting new results. The stronger the imaginative power, the greater must be the chance of success. *The Times*, in a recent leading article on Science and Imagination, says:—"It has often been said that the great scientific discoverers . . . see a new truth before they prove it, and the process of proof is only a demonstration of the truth to others and a confirmation of it to their own reason." While never forgetting the essentially tentative nature of a hypothesis, still, until it has been tested and found wanting, there should be some confidence or faith in its truthfulness; for nothing but a belief in its eventual success can serve to sustain an inquirer's ardour when, as so often happens, he is met by difficulties well-nigh insuperable. In a well-known passage Faraday says:—"The world little knows how many of the thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and secrecy by his own severe criticism and adverse examination; that in the most successful instances not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realised."

But a hypothesis to be useful, to be admitted as a candidate for rank as a scientific theory, must be capable of immediate, or at least of possible, verification. Many years ago, in the old Berlin laboratory in the Georgenstrasse, when our imaginations were wont, as sometimes happened, to soar too far above the working benches, our great leader used to say:—"I will listen readily to any suggested hypothesis, but on one condition—that you show me a method by which it can be tested." As a rule, I confess we had to return to the workaday world, to our bench experiments. No one felt the importance of the careful and correct employment of hypotheses more than Liebig. In his Faraday lecture Hofmann says of Liebig:—"If he finds his speculation to be in contradiction with recognised facts, he endeavours to set these facts aside by new experiments, and failing to do so he drops the speculation." Again, he gives an illustration of how on one occasion, not being able to divest himself of a hypothesis, he missed the discovery of the element bromine. While at Kreuznach he made an investigation of the mother-liquor of the well-known salt, and obtained a considerable quantity of a heavy red liquid which he believed to be a chloride of iodine. He found the properties to be different in many respects from chloride of iodine; still, he was able to satisfy all his doubts, and he put the liquid aside. Some months later he received Balard's paper announcing the discovery of bromine, which he recognised at once as the red liquid which he had previously prepared and studied. Thus, though imagination is indispensable to a chemist, and though I think chemists should be, and let us hope are, poets, or at least possess the poetic temperament, still, little can be achieved without a thorough laboratory training; and he who discovers an improved experimental method or a new differentiating reaction is as surely contributing to the advancement of science as he who creates in his imagination the most beautiful and promising hypothesis.

It may never be possible to trace in civilisation's early records the exact period and place of the origin and beginnings of our science, but the historical student has been led, it appears to me, by a sure instinct to search for this in such lands of imaginative story as ancient Egypt and Arabia. For is there anything more fittingly comparable with the marvellous experiences of a chemical laboratory than the wonderful and fascinating stories that have come down to us in "The Arabian Nights"? Those monuments of poetic building of which Burton, in the introduction to his great translation, says that in times of official exile in less-favoured lands, in the wilds of Africa and America, he was lifted in imagination by the jinn out of his dull surroundings, and was borne off by him to his beloved Arabia, where under diaphanous skies he would see again "the evening star hanging like a golden lamp from the pure front of the western firmament; the after-glow transfiguring and transforming as by magic the gazelle-brown and tawny-clay tints and the homely and rugged features of the scene into a fairyland lit with a light which never shines on other soils for seas. Then would appear," &c. I cannot help thinking that the study of such books as this, the habit of exercising the imagination by reconstructing the scenes of beauty and enchantment which they describe, might do much to strengthen and sharpen the imaginative faculty, and greatly increase its efficiency as an indispensable tool in the hands of the pioneer who seeks to extend the boundaries of knowledge. *The Times,* in the leading article already quoted, says that, as with a Shakespeare, "it is the same with imaginative discoverers in science. . . . But the faculty is not merely a fairy gift that can be exercised without pains. As the sense of right is trained by right action, so the sense of truth is trained by right thinking and by all the labour which it involves. That is as true of the artist as of the man of science; and one of the greatest achievements of science has been to prove this fact and so to justify the imagination and distinguish it from fancy."

Again, let it not be forgotten that chemistry in its highest sense—that is, in its most general and useful sense—is purely a world of the imagination, is purely conceptual. And in addition to this, moreover, it is based, like all science, on the underlying assumption of the uniformity of Nature, an assumption incapable of proof. If we think of the science as a body of abstract general theory, and exclude for the moment from our purview its innumerable practical applications, and also all special individual facts not yet known to be related to general theory, then what remains are the more or less general facts or laws. These it is which give the power of prediction in newly arising cases of a similar character; the power of foresight by which the claim of chemistry to its position as a science is justified. Chemistry, as such, is a complicated ideal structure of the imagination, a gigantic fairy palace, and, be it noted, can only continue to exist so long as there are minds capable of reproducing it. Think of all the speculation—and speculation too of the highest utility when translated into concrete applications—about the internal structure of molecules. I venture to say that the most magnificent creations of the world's greatest architects are not more elaborate or more beautiful or more fairylike than the chemist's conception of intramolecular structure and the magical transformations of which molecules are capable; and yet no one has had direct sensuous experience of any molecule or atom, or possibly ever will. It is well from time to time to recall these truths and realise where we are. But although the conceptual nature of science is unquestionable, it certainly contains truth in some form as tested by deductive concrete realisation, by correctness of prediction, and during the last century or two has undoubtedly given to man a mastery over Nature never before dreamt of.

A Brief Historical Retrospect.

The foundations of chemistry, as we now know it, were laid under the influence, the guidance, of three great theories: first, the theory of the alchemists of the transmutation of metals by means of the philosopher's stone; second, the theory of phlogiston, connected so much with the names of Becher and Stahl, which held sway for some two centuries; third, the theory of combustion, the quantitative period of chemistry, inaugurated by the great Scottish chemist Black by his introduction of the balance. How this led to a veritable renascence of chemistry in the hands of Lavoisier and the other giants of that stirring period—the close of the eighteenth and commencement of the nineteenth centuries—is well known. Looking back at the warfare which was waged about these older theories, for and against them, one realises now that there were elements of truth on both sides; for have we not in the work of Sir William Ramsay and others the revival of transmutation, and does not the essential truth of phlogiston survive in the modern doctrine of heat? In one of Dr. Johnson's letters to Boswell there is a curious reference to transmutation. He says that a learned Russian had at last succeeded, but, fearing the consequences to society, he had died without revealing the secret.

After the discovery of oxygen and the beginnings of quantitative chemistry, the science was ready for Dalton's great discoveries respecting combination by weight; the corresponding discoveries by Gay-Lussac on combination of gases by volume, and, through the latter, for Avogadro's famous hypothesis. Dalton had indeed, by reviving an old Greek suggestion, proposed to explain his discoveries by his atomic theory, but neither this nor our molecular theory, though the latter was inherent in the laws of gaseous combination of Gay-Lussac and in Avogadro's hypothesis, was finally put upon its present basis until Cannizzaro took up the subject half a century later. Meanwhile Dulong and Petit had completed their studies of atomic heat, and Mitscherlich had pointed out the relation between isomorphism and molecular structure. When it is considered how little is known of solid or liquid structure, and that our present knowledge of molecules is only of gaseous molecules, it is fortunate that these methods of study of solids are available. The same may be said of the results of the work of Kopp and his successors on molecular volumes. Of other aids to fixing our conception of molecules and atoms I need only refer to the periodic law, the studies of the properties of dilute solutions, of electrolytic dissociation, and of surface tension of liquids.

Liebig, in his first inquiry, begun before he went to Gay-Lussac in Paris, proved that silver fulminate and silver cyanate, though distinct substances, had exactly the same composition; thus was opened that great chapter in the history of chemistry which Berzelius named isomerism. Perhaps nothing in chemistry has given rise in recent years to more intellectual and practical activity than isomerism. Wöhler's classical synthesis of urea, by the metastasis of ammonium cyanate, added another instance of isomerism, and Berzelius soon afterwards announced the isomerism of tartaric and racemic acids. Wöhler's synthesis of urea, followed, as it was, by numerous other laboratory syntheses, showed that substances which occur in living organisms are not different from those which may be prepared artificially, and the old distinction between inorganic and organic chemistry disappeared there is, of course, only one chemistry. The words, it is true, have survived, but only for reasons of practical convenience.

After isomerism the next great step forward in the study of intra-molecular structure was the discovery of groups partially individualised which are capable of remaining intact through many reactions. Gay-Lussac had previously noticed the cyanogen group as common to cyanides; but it was the celebrated paper by Wöhler and Liebig on the radical of benzoic acid which finally established the existence of compound radicals or groups such as benzoyl, and obtained for the theory of compound radicals the position in chemistry it now holds. Bunsen followed somewhat later with the discovery of cacodyl, and now such groups are almost innumerable. In many respects, by the experimental skill which it shows, the clearness of its logical method, and the beauty of its form and diction, this memoir is a model of what a scientific communication should be. I will read the opening paragraph, using Hofmann's translation:—"When a chemist is fortunate enough to encounter, in the darksome field of organic nature, a bright point affording him guidance to the true path by following which he may hope to explore the unknown region, he has good reason to congratulate himself, even though he may be conscious of being still far from the desired goal." Of this memoir Berzelius, in a letter quoted by Hofmann (Faraday lecture), says:—"The facts put forward by you give rise to such considerations that they may well be regarded as the dawn of a new day in vegetal (organic) chemistry."

The history of the advance of chemistry since the days of the Giessen laboratory is bewildering in its extent. This has been largely due to the Giessen laboratory itself, which sent trained investigators, each carrying with him some touch of its master's magic, into all civilised lands. I cannot attempt to even catalogue the results here. One thing may be said, that chemistry is not worked out, as some have thought; but rather the opportunities of discovery seem greater and more promising than at any previous period.

PART II.

Sub-atoms, Atoms, Molecules, Molecular Aggregates; Valency.

Whether in the light of recent researches it may become necessary to give up that portion of Dalton's theory of atoms in which he regards them as undecomposable and indivisible; or whether we may consider them, as Prout suggested a hundred years ago, as different aggregates of sub-atoms of a uniform kind of matter; or whether they must be regarded as complexes built in the manner supposed by the electron hypothesis; also what should be our attitude towards the related problem of transmutation—all this I pass over, the more willingly that these subjects were discussed so recently by so high an authority as Sir William Ramsay in his address to the Association last year at Portsmouth.

I assume that we are fairly satisfied with our present atoms and their respective weights, and this no matter how the atoms are constructed, and that we shall be satisfied with them so long as they disport themselves in chemical changes as indivisible entities. And further, I assume that we are satisfied with our molecules and their respective weights, as determined by the application of Avogadro's hypothesis. Whether the molecular weight is obtained by direct determination of gaseous density or by taking advantage of the properties of dilute solutions, in either case the molecular weight which results is the weight of a supposed gaseous molecule, for the latter method depends for its justification on the former. All our molecular weights are weights of molecules in the gaseous state or are supposed to be; they are not necessarily applicable to liquids, and much less to solids: solids and liquids may well consist of far more complex particles.

Gradually the central problem of chemistry has become more and more the study of internal structure of molecules—of gaseous molecules. The enormous number and variety of the compounds of carbon, with which so many workers have enriched the science during the last hundred years, and the special adaptability of these compounds to the experimental study of molecular structure, have led investigators to make use of them rather than of the so-called inorganic compounds: thus out of inquiries into the intramolecular structure of these compounds arose and were developed the theories of types of Gerhardt, Williamson, and Kekulé. These are now, however, looked upon more as aspects of the general problem. More fruitful has been the study of the compound radicals or individualised groups of Wöhler and Liebig. But gradually these molecular structures have been regarded, in agreement with the views of Dumas, as complete wholes; like fairy temples, which from different points of view show different parts in relief, accentuating, it may be, this or that column or frieze or pediment. Kekulé's brilliant and suggestive theory of chain compounds and ring compounds did more than any other theory to guide and stimulate research in chemistry in recent times. Like Gay-Lussac's theory of gaseous combination, though built in the first place only upon a few facts, this theory has proved true of the thousands of others with which we have since become acquainted; there seems indeed to be a need of a new psychology to account for such truly marvellous foresight as is here exhibited. The atoms forming these varied structures were, however, regarded as being arranged in a plane, until the great discoveries of Pasteur made it necessary for chemists to extend their conceptions and to frame hypotheses of three dimensions. Thus have arisen in the hands of Le Bel and van't Hoff and others our modern theories of stereo-chemistry. When isomerism occurs in an element Berzelius names it allotropy. It seems to me that now, when molecules of the elements do not differ essentially from molecules of compounds, there is no longer any distinctive meaning in the term, and that it might well be abandoned. I would like also to make another suggestion respecting nomenclature: that when we distinguish ring compounds as *cyclic* we might appropriately adopt the word *hormathic* (from the Greek word for a chain or a row) for chain compounds.

But in order to understand the linking of atoms in these molecular edifices some combining value had to be assigned to the different atoms. This idea of valency of the atoms was, no doubt, implied in Gerhardt's theory of types; but it did not gain much attention until later, when Frankland and Kolbé formulated an empirical theory of variable valency. Kekulé thought that atoms could not vary in their valency; but the alternative formulæ which he put forward to explain cases of difficulty would appear to be, rather, an attempted explanation of variable valency. It might be more correct to say that Kekulé's formulæ constitute an anticipation of Werner's theory of auxiliary valencies, the theory which seems to find most favour at the present day. Fixed valency can scarcely now be defended, in view of the existence of such compounds, for example, as the two fluorides and the two chlorides of phosphorus; the two oxides of carbon, ammonia and ammonium chloride; and, for example, the two series of compounds respectively of iron, mercury, and copper. Variable valency of atoms is, empirically at least, an establish fact.

By the latest conceptions of variable atomic valency and its extension almost without limit—so that, for example, oxygen may be regarded as quadrivalent and even sexivalent—no doubt the existence of numerous compounds which previously presented difficulties can be explained. There are, however, others long known to chemists, such as double salts and the combination of water with salts, formerly called "molecular compounds," definite and individual, in which these views do not assist us. These compounds do not exist as gases, and unless they admit of experimental study by the methods of dilute solution, even their gaseous molecular weights cannot be ascertained.

It is noteworthy that in most of the instances recently investigated where variable valency has been assumed the compounds studied have been easily decomposable solids or liquids, and for one reason or another their gaseous molecular weights could not be determined. Many of these compounds, indeed, only exist at low temperatures. As instances of work of this kind I may mention Collie and Tickle on quadrivalent oxygen in dimethylpyrone derivatives; Gomberg on triphenylmethyl; Landolf on acetone dihydrofluoride; Thiele and Peter on methyl-iododichloride; and similar studies by Kehrmann, Willstatter and Iglauer, Bülow and Sicherer, Baeyer and Villiger, Archibald and McIntosh, Chattaway, Pfeiffer and Truskier, and others.

Another most interesting class of solids which are capable of existing in two isomeric forms distinguished from each other by such physical properties as density or colour are the Schiff's basis or anils. Some of these were studied by Hantzsch, who proposed to explain their existence by the Hantzsch-Werner stereo hypothesis:—

$$\begin{array}{c} HO.C_6H_4.CH \\ \| \\ NR' \end{array} \qquad\qquad \begin{array}{c} HC.C_6H_4OH \\ \| \\ NR' \end{array}$$

But since only a few, and these not very satisfactory, compounds show this isomerism, which do not contain the hydroxyl group, other suggestions have been put forward to account for the isomerism, by Anselmino and by Manchot.

In my own laboratory, associated with Mr. F. G. Shepheard and also with Miss Rosalind Clarke, I have made a study of various Schiff's bases for the purpose of investigating the remarkable property which some of these bases exhibit of *phototropy*. By phototropy is meant the capability of reversible change of colour in solids depending upon the presence or absence of light. Incidentally, too, I wished to study another physical property which many Schiff's bases possess, in common with other substances, of reversible change of colour with raising or lowering of temperature. This property we have called *thermotropy*, and many old instances will be remembered of substances of simpler constitution which exhibit it: thus, when subjected to the temperature of solid carbon dioxide, ordinary sulphur becomes colourless, red oxide of mercury becomes yellow, vermilion becomes scarlet, and on return to the ordinary temperature the original colours reappear.

As has been pointed out in a recent communication by Biilman, it is most important in these discussions that we should be perfectly clear in the use of terms. I take it for granted that *isomerism* is a general term for compounds differing in some respect but having the same composition. If the molecules (gaseous) have the same weights they are *metamerides*; if of different weights they are *polymerides*. When solids crystallise in more than one form they are *polymorphous*. Now it does not seem reasonable to suppose that reversible colour changes such as those exhibited by phototropes or thermotropes involve such violent intra-molecular changes as the breaking and reconnecting of atomic linkages. For example, take the three bases, salicylidene-*m*-toluidine, which in the dark or immediately it is exposed to light is yellow, but on continued exposure to light quickly becomes orange, and changes back again to its original colour in the dark; salicylidene-*m*-aminophenol, which at ordinary temperatures is orange, but is much paler at the temperature of solid carbon dioxide, on raising the temperature to nearly the melting-point (128·9°) becomes orange red, and these changes take place in the reverse order again on cooling; salicylidene-*p*-aminobenzoic acid, studied by ourselves and by Manchot and Furlong independently, shows a wider range of thermotropic change between bright yellow and blood-red, and is also phototropic. To explain such changes as these and the others of a similar nature previously referred to, I think some less drastic hypothesis should be sought than intra-molecular breaking, and consequent metastasis or polymerisation. Though doubtless the hypothesis of Hantzsch and Werner could be invoked, or the modified hypotheses of Manchot or Anselmino, I think there should be some simpler explanation. Someone suggests polymorphism. Now polymorphism means that a change of crystalline form takes place which might doubtless connote change of colour. If one watches phototropic crystals changing colour under the influence of light from yellow to red, and notices that after remaining in the dark the same crystals have changed back to the original colour, and, remember, that these changes can be repeated with the same crystals apparently without limit, it will not be considered likely that this phenomenon depends on a reversible change of crystalline form. In a communication to the Chemical Society some three years ago Mr. Shepheard and I put forward the following suggestion:—"Evidence is accumulating of reversible isomeric reactions, like those described in this paper, which are indicated by physical differences, such as changes of colour. It is possible that these may be explained by hypotheses, similar to that of Hantzsch and Werner, assuming intra-molecular rearrangement; but in the case of phototropy and thermotropy it should not be forgotten that the substances exhibiting these phenomena are solids. No one will doubt, however, that these differences of colour depend on isomeric change of some kind, but in the case of solids we know practically nothing of their molecules, not even of their relative molecular weights. The molecules of solids are probably far more complex than those of liquids or gases; indeed, they may be rather complex groups or aggregates of ordinary gaseous molecules, which would give rise to far more numerous possibilities of isomerism. It appears to us that phototropic and thermotropic reactions are more probably due to isomeric changes affecting the aggregation of molecules in solids than to intra-molecular change of molecules derived from a study of gases."

It seems to me that just as atoms may be structures built of sub-atoms of some kind, and just as molecules of gases are built of atoms variously linked together, it is reasonable to conceive that molecules might combine to form aggregates, particularly when constituting solids; that as the sub-atoms may be conceived to have a combining valency—and the atoms are already accredited with this property, and in addition, as is supposed with Thiele's partial or Werner's auxiliary valencies—molecules may have valencies also whereby to combine into molecular aggregates. It may be presumed that such aggregates are more complicated in structure, and thus may give rise to greater variety of isomerides, and be more readily transmutable than gaseous molecules. If such aggregates of gaseous molecules exist they might explain not only the easily changed isomerides recently studied, but also the large class of "molecular compounds" of the older chemists. I imagine someone saying that in suggesting this hypothesis—which by the way is not new, for it is mentioned in Ostwald's "Outlines"—I am violating the canon to which I have myself subscribed, as a condition of a scientific hypothesis, that it should be verifiable. Perhaps we carry our critical faculty sometimes too far. It is most highly scientific to doubt, but doubt which is merely destructive has little value; rather, with Descartes, it should lead on to construction, for he who builds even imperfectly is better than he who simply destroys. And I do not doubt that some way will be found to study solids and obtain data that will lead to the determination of their molecular aggregate weights. The study of molecular volumes of solid solutions; the remarkable results obtained by Pope and Barlow; Tutton's work on crystallography, and much besides, induce the hope that some day solids, like gases, will find their Avogadro.

Part III.

Pursuit of Chemistry Justified by its Useful Applicability.

In the pursuit of all this abstract theory, and still more so in the bewildering multitude of undigested individual facts, there is danger that important and fundamental, even moral, considerations may be lost sight of. For example, take the fundamental question: Why should we pursue chemistry? No doubt it is considered by its votaries, those who seek in our laboratories to advance the science, that they are entitled to have provided for them, and will be rewarded by the provision of, the ordinary means of livelihood; but these, it will scarcely be denied, could generally be far better assured by other pursuits. It is suggested that intellectual discipline is a reason; but, I ask, for what purpose? Will anyone pretend that intellectual discipline without utilitarian object, without the possibility of using it for the betterment of society, is a worthy pursuit? I think not. But, in any case, none of us have devoted ourselves to chemistry merely for the sharpening of our wits. Again, someone suggests that chemistry and learning generally should be pursued for their own sake. In a recent most interesting and inspiring academic address[1] Prof. Sir Walter Raleigh commends "those who seek nothing from knowledge but the pleasure of understanding." If such a statement bears its most obvious meaning then, I venture to think that, in common with intellectual discipline without the intention of applying to a useful object the intellect so trained, such a reason is selfish, inadequate, and unworthy, and does not justify the pursuit of anything. No; research in chemistry apart from the possibility of applying it to the advantage of humanity cannot be defended. The mastery of the seemingly unlimited resources of Nature which chemistry achieves more and more and its use to alleviate the misery and add to the happiness of mankind are the only worthy and effective defence. And that this is the underlying ideal, in point of fact, that leads the chemist onward, not necessarily that he is always conscious of it, but always when he reflects, I think cannot be doubted. But, of course, no narrow idea of utility must be aimed at. Practically any chemical inquiry may lead to results of material advantage. Certainly nothing could be more mischievous than to make a narrow immediate utility the test. It would be easy to illustrate all this from the records of science, but instances in point are so well known that it is unnecessary.

On the other hand, it should not be forgotten that in making use of the manifold advantages derived from the growth of science, humanity, on its part, owes a great debt to scientific inquirers, and ought to feel it a sacred duty to do in return all in its power by support and encouragement to further scientific research. As Sir Walter Raleigh, in the address already referred to, says:—"It is so easy to use the resources of civilisation that we fall into the habit of regarding them as if they were ours by right. They are not ours by right; they come to us by free gift from the thinkers."

Some Concrete Applications of the Science.

That this advantage to civilisation has been, and is, the result of the pursuit and consequent advance of chemistry is happily a truth that is well known. There is scarcely an industry or a profession that has not been materially influenced or even created by the discoveries of chemistry, and therefore the welfare of nations is most intimately concerned in promoting its advancement. Now, it is common knowledge that no country has appreciated this to the same degree as Germany. It will, therefore, be worth our while to consider a moment the inauguration in Berlin, a year ago, of an entirely new institution, the Kaiser Wilhelm Institut, for the promotion and organisation of chemical research. This research is to be effected throughout the German Empire, in the universities, the technical high schools, or in works, and it is supported mainly, at least at first, by subscriptions of the chemical manufacturers. An address of very great importance was delivered at its opening by Prof. Emil Fischer, than whom, perhaps, no one living has added more to the progress of chemistry. A translation of this address appeared in Nature, and, with additions, has since been published in a convenient book form.[2] In this address an authoritative account is given of the main contributions of chemistry to the national welfare, which even to those familiar with the subject must be astonishing in their importance, variety, and universality. It includes the applications of the science to problems of nourishment, to agriculture, and food supply; to engineering, metallurgy, cements; to clothing, artificial silk, or to colouring—dyes; to indiarubber production, both natural and artificial; to perfumery—artificial violet and other artificial floral perfumes, even that of the rose; to synthetic camphor; to drugs and synthetic materia medica, including the recent arsenic and selenium organic compounds which promise so much in the treatment of cancer and other fatal diseases; to radio-activity, to therapeutics, to the destruction of pathogenic microbes; to methods of sewage disposal; to the preparation of efficient ex-

1 "The Meaning of a University." (Clarendon Press, 1911.)

2 "Chemical Research in its Bearings on National Welfare." (London, 1912.)

plosives; and to many other useful objects. In connection with the manufacture of explosives the public should know that the ability to wage war is becoming more and more dependent on the work of chemists. When the supply of mineral nitrates is exhausted, or even before that event, the requisite nitrogen compounds will have to be provided in some other way, and almost certainly they will be obtained synthetically from the atmospheric gases which even now are becoming a commercial source.

The Time-spirit and Science.

But students of history know that there are certain periods that for some unexplained reason are specially fruitful in certain departments of intellectual or artistic development. Prof. Sir Walter Raleigh, for instance, a high authority on this subject, says:—"The human body, so far as we know, has not been improved within the period recorded by history; nor has the human mind, so far as we can judge, gained anything in strength or grace." Further, regarding literature:—"The question is not by how much we can excel our fathers, but whether with toil and pains we may make ourselves worthy to be ranked with them." Again:—"In the beautiful art which models the human figure in stone or some other enduring material, who can hope to match the Greeks? In the art of building who can look at the crowded confusion of any great modern city, with all its fussy and meaningless wealth of decoration, like a pastrycook's nightmare, and not marvel at the simplicity, the gravity, the dignity and the fitness of the ancient classic buildings? How can the seasoned wisdom of life be better or more searchingly expressed than in the words of Virgil or Horace, not to speak of more ancient teachers?" Thus all things are not progressing. The time-spirit now, and for some two centuries past, seems to have chosen to take under its particular guardianship the physical and natural sciences, their cultivation and applications, rather than philosophy or architecture or sculpture, or painting or literature. We shall do well to recognise this, and not waste our resources in striving to fight against it.

Present Indiscriminate Elementary Teaching and Neglect of Research.

Large sums of money are expended in this country on the diffusion of some knowledge of chemistry among all classes of scholars and students; in fact, scarcely anyone escapes from a smattering, largely undigested if not indigestible, either forced on them by regulations or by allurements of bribes in the form of prizes, scholarships, or academic laurels. And if this is not good for scholars and students, it is worse for masters or professors. Our professors work "whole time" at this "stall-feeding" process, and if they happen to be strong men mentally and physically they may be able when weary with work to devote any overtime to—what I submit is far the more important matter for the State—the advancement of science by research. But this pursuit requires, for its successful prosecution, for resource and initiative to be at their best, that all the faculties should be in readiness in their fullest strength, freedom, and adaptability. How many, alas! are not strong men, and in their praiseworthy endeavours, notwithstanding, to contribute something to the achievements of their time succumb as martyrs to their devotion. The truth of this statement, I fear, is too well known to many of us here. In Germany this strain of elementary teaching is more recent, and is only now being felt. Prof. Emil Fischer in his address (*loc. cit.*) says of it: "During the last ten years a scheme of practical education of the masses has developed." "But this very education of the masses tends mentally to exhaust the teacher, and to a great extent, certainly to a higher degree than is desirable or indeed compatible with the creative power of the investigator, there prevails in modern educational laboratories a condition of overstrained activity." And again, "In the harassing cares of the day the teacher too readily loses that peace of mind and broad view of scientific matters necessary for tackling the larger problems of research." Laboratories, he says, are wanted "which should permit of research in absolute tranquillity, unencumbered by the duties of teaching." I have given these quotations from Prof. Fischer's address as indicating the matured judgment of a highly competent authority, communicated in the presence of the German Emperor on an historic occasion. His words are words of great weight, and no country which regards its future welfare can afford to ignore them.

Sir Walter Raleigh (*loc. cit.*) says that every university is bound to help the poor . . . but that does not mean that a university is doing good if it helps those who have no special bent for learned pursuits to acquire with heavy labour and much assistance—just so much as may enable them to pass muster; on the contrary, it is doing harm. I would like to invite the attention of all who are seriously interested in the country's welfare to reconsider the present policy in the teaching of chemistry; and this applies also to other sciences. For the advancement of civilisation, for the increased welfare of the race by the technical applications of our science, it is not the indiscriminate teaching of the masses and the multiplication of examinations that is wanted, but the training of the few, of capable investigators. I do not propose necessarily that we should interfere with, or much less abandon, much of our present elementary teaching, and I know that elementary, largely technical, training in chemistry is needed for medicine and engineering; but I do propose that our first endeavour should be to secure under present conditions in the present college or works laboratories, or in laboratories to be specially provided, that capable men, of whom we have many, should be able to devote themselves to research without the worry of teaching and examining or of providing the ways and means of livelihood. There is, happily, reason to believe that this vital need is to some extent becoming known; for there have been several recent instances where a particular investigator has been afforded the means, financially, of prosecuting his particular researches in tranquillity. The diversion of endowments to such purposes, instead of their going to the foundation of additional school or undergraduate scholarships, cannot be too highly commended.

We may learn a lesson which bears on this from that remarkably prolific period of our science, the close of the eighteenth and the beginning of the nineteenth centuries. It was then no easy matter to pass the precincts of a chemical laboratory; only the fittest survived the ordeal. At the beginning of the nineteenth century the traditions of Berthollet and Lavoisier in Paris were kept alive by Gay-Lussac; in England those of Cavendish and Priestley by Davy; and Berzelius in Sweden worthily maintained the older school of Bergmann and Scheele. By a happy fate the interest of Alexander v. Humboldt was the means of both Liebig and Dumas being admitted to the intimacy of Gay-Lussac; and in Sweden Wöhler was fortunate to gain the confidence of Berzelius; and in London, Faraday that of Davy. The achievements of these men—Liebig, Dumas, Wöhler, and Faraday—are part of the history of science. To me it contains a lesson, in point, of great importance. The opportunity offered them was beset with difficulties. No bribes such as scholars or students expect to-day were offered them; they knew no examinations, and their available apparatus and laboratory equipment were of the smallest and crudest description; but they were eager students with whom the master was in sympathy, and it is common knowledge that they completed the foundations of our science. Now I ask, considering the thousands of students whom we teach and examine to-day, are we doing as well in the interest of the country as our predecessors a century ago? Who can confidently answer in the affirmative? No; whatever else is done, the country needs the provision of men whose untrammelled energy should be devoted to original chemical research. Even as intellectual discipline the value of research is of the highest importance. In his address to the British Association at Winnipeg, Prof. Sir J. J. Thomson bears testimony to this. He says: "I have had considerable experience with students beginning research in experimental physics, and I have always been struck by the quite remarkable improvement in judgment, independence of thought, and maturity produced by a year's research. Research develops qualities that are apt to atrophy when the student is preparing for examinations, and, quite apart from the addition of new knowledge to our store, is of the greatest importance as a means of education."

And the object and ideal are wrong also in our system of technical training. We aim too much at giving elementary instruction to artisans, which, though important in itself, can never take the place of the higher education of leaders or managers of industrial works. This is different in Germany, where, although the training of artisans is by no means neglected, the chief energy is directed to the training and teaching of the smaller class of managers. There is, too, in Germany a far more intimate relation between academic and industrial work, and the leaders in each often interchange posts. In one respect we have an advantage over Germany; it is important that this should be understood. The higher technical instruction across the Rhine has not been undertaken by the universities, but is carried out in separate institutions. With us the universities have gradually undertaken, in addition to the older technical subjects, theology, medicine, and law, the various branches of engineering and agriculture, and even commerce. This, it is to be hoped, will be extended so that the highly trained technologist may have the advantage of the undoubted humanising influence of the university.

Conclusion.

I have not attempted in this address any complete survey of chemistry, either its growth in the past or its present condition, but I have endeavoured to give some account of the sort of thing chemistry is—of its method—and to maintain three theses: (1) That the logical method by which chemistry advances is not a simple one, and requires as one essential element the use of a highly developed imagination. To render this more efficient I have advocated special training. (2) Without violating, I hope, the canons of the proper use of hypothesis, I have proposed, in order to account for certain isomeric and other phenomena, the conception of solid molecular aggregates, although I am not able at present to indicate precise methods for its further investigation. These molecular aggregates are supposed to be formed by the combination of gaseous molecules just as the latter are formed by the combination of atoms. (3) As a matter of vital interest to the continued well-being of this country I have insisted strongly that our educational resources devoted to chemistry should be directed, in the first place and chiefly, to the highest possible training of promising students in the prosecution of research, and that the giving to the many of elementary instruction should be at least a secondary consideration.

Now I do not wish to dictate how this last proposition could be best carried into effect. I think we should distinguish three classes of chemists, or technical chemists, whose domains would more or less overlap. Occasionally there will be a man, like the late Sir William Perkin, who would combine all three. The three classes are: first, the pure chemist, devoted to scientific discovery only; second, the technical chemist, who prepares the discoveries of the pure chemist for the technologist, and has to determine such questions as economical production and, for example, the conversion of colours into dyes; third, the technologist or works manager. These three classes should be in close relation to one another. By such a scheme we should probably overcome by education one of our most serious present difficulties—the ignorance of owners of works of the value of science.

It is a matter deserving most earnest consideration whether, under the propitious influence of our own time-spirit, it would be possible to organise research and develop it without interfering with its essential freedom and initiative, and this in each of the three classes I have mentioned, either by means of some of our existing institutions, or by the inauguration here of such an organisation as the Kaiser Wilhelm Institut in Berlin.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY B. N. PEACH, LL.D., F.R.S., PRESIDENT OF THE SECTION.

The Relation between the Cambrian Faunas of Scotland and North America.

Introduction.

EVER since the announcement made by Salter in 1859 that the biological affinities of the fossils found in the Durness Limestone are more closely linked with American than with European forms, the relation between the older palæozoic faunas of Scotland and North America has been a subject of special interest to geologists. The subsequent discovery of the *Olenellus* fauna in the north-west Highlands furnished striking confirmation of Salter's opinion. This intimate relationship raises questions of prime importance bearing upon the sequence and distribution of life in Cambrian time in North America and north-west Europe, on the probable migration of forms from one life-province to another, and on the palæogeographical conditions which doubtless affected these migrations.

On this occasion, when the British Association revisits the border of the Scottish Highlands, it seems appropriate to refer to some of these problems. With this object in view I shall try to recapitulate briefly the leading features of the life-history of Cambrian time in Scotland and North America, to indicate the relation which these life-provinces bear to each other, and, from these data, to draw some inferences regarding the probable distribution of land and sea which then obtained in those regions.

The two great rock groups in Scotland that are universally admitted to be older than Cambrian time are the Lewisian Gneiss and the Torridon Sandstone. The Lewisian Gneiss, as mapped by the Geological

Survey, consists mainly of igneous rocks, or of gneisses and schists of igneous origin. But, in addition to these materials, we find, in the Loch Maree region, schists o sedimentary origin, comprising siliceous schist, mica-schist, graphite-schist, limestone, chert, and other sediments. The association of graphite-schist with limestone and chert suggests that we are here dealing with rocks that were formed at or near the extreme limit of sedimentation, where the graphite, the limestone, and the chert were probably accumulated from the remains of plankton. But this assemblage has been so completely altered into crystalline schists that all traces of original organic structure in them have been destroyed.

The Torridonian strata were evidently accumulated under desert or continental conditions, and could therefore furnish little or no evidence bearing upon the development of marine life. That life existed, however, is clear from the presence of phosphatic nodules, containing remains of cells and fibres of organic origin, in the upper division of the system, and from the presence of worm burrows and casts in the Diabaig beds (Lower Torridon).

Geologists are familiar with the fact that the Cambrian faunas all over the globe present highly specialised types belonging to most of the great groups of marine invertebrate life. Scotland is no exception to this general rule. For the fossils prove that their ancestors must have had a long history in pre-Cambrian time.

The Cambrian Fauna of Scotland.

Beginning with the false-bedded quartzites forming the basal sub-division of the Cambrian strata in the north-west Highlands, we find no traces of organic remains in them, except at one locality, where worm casts (*Scolithus linearis*) were obtained. In the upper subdivision of the quartzites—the pipe-rocks—the cylinders of sand are so numerous that the beds have been arranged in five subzones, based on a definite order of succession of different forms probably of specific value. One of them, *Arenicolites* of Salter, may be of generic importance. Worms of this habit are confined to comparatively shallow water, and therefore near the shore line. Their occurrence helps to confirm the belief that the quartzites were laid down on an ancient shelving shore line during a period of gentle subsidence. Their presence also indicates the existence of plankton, from which they derived nourishment. Besides the relics of these burrowing annelids, one of the subzones of the pipe-rock has yielded specimens of *Salterella* (*Serpulites Maccullochii*)—a tubicolar annelid, which becomes more abundant in the overlying fucoid beds, serpulite grit, and basal limestone, where it is associated with *Olenellus* and other typical Lower Cambrian forms.

The fucoid beds, which immediately overlie the pipe-rocks, consist chiefly of shales and brown dolomitic bands, with intercalations of grit locally developed. This type of sedimentation indicates that the mud line was superimposed on the shore line by subsidence. With this change of conditions there is a change of organisms, for though the burrowing forms (*Scolithus*) are still to be found in the sandy layers, the most characteristic types are those occurring along the bedding planes, known under the name of *Planolites* (Nicholson). They are very varied forms, and were probably produced by many types of errant annelids. The tubicolar annelids are represented by *Salterella, Coleoloides*, and *Hyolithes*—an organism which perhaps links the worms with the hingeless brachiopods. This suggestion gains additional support from the researches of Dr. Walcott in the Middle Cambrian rocks of Canada. It is interesting to note that small annelids seem to have bored the spines of dead trilobites. Walcott has found similar borings in the chetæ of annelids in the Middle Cambrian rocks of Canada.[1]

The researches of Dr. Walcott have proved beyond doubt that representatives of nearly all the divisions of the annelids are entombed in the Middle Cambrian rocks of Mount Stephen, in British Columbia. We may therefore reasonably infer that the worm casts of *Scolithus* type found in the north-west Highlands are due to annelids. He has also shown that wormlike holothurians are to be found in the same beds.[2] In this connection it may be observed that some of the recent holothurians have much the same habit of obtaining nourishment from the sands and silts containing organic matter.

Fragments showing the characteristic microscopic structures of the plates and ossicles of echinoderms have been found in the fucoid beds. These are possibly Cystidean. Hingeless forms of brachiopods also occur, among which may be mentioned *Paterina labradorica* and *Acrothele subsidua*. The type of *Acrothele* suggests a genetic descent from such a tubicolar worm as *Hyolithes*. Of the gasteropods, only one specimen, belonging to a subgenus of *Murchisonia*, has been obtained at one locality in Skye. *Helenia bella*, a curved calcareous tube, open at both ends, doubtfully referred to the *Dentalidae* by Walcott, is comparatively plentiful. It occurs also in the *Olenellus* zone in Newfoundland.

But the organic remains that render the fucoid beds of exceptional interest and importance are the trilobites, because they clearly define the horizon of this zone in the Cambrian system and display strong affinities with American types. They are represented by five species and varieties of *Olenellus*, very closely resembling the forms in the Georgian terrane, or *Olenellus* zone, on the east and west sides of the North American continent. The genus *Olenelloides* has also been recorded from these beds. The crustacea are represented by phyllocarids, among which we find *Aristozoe rotundata*, likewise characteristic of the *Olenellus* zone of North America.

Next in order comes the serpulite grit, which indicates a recrudescence of the pipe-rock conditions of deposition, and presents the *Scolithus* type of annelid borings. From the diameter of the pipe and the depth of the burrow it is probable that the worm may have belonged to a different species from any of those the casts of which are to be found in lower horizons. This large variety is associated with smaller and more irregular worm casts which have often weathered out and leave the rock honeycombed with hollow casts. The characteristic form from which the zone takes its name is *Salterella* (*Serpulites Macculochii*). It occurs abundantly along certain calcareous layers that mark pauses in the deposition of the sand. This calcareous type culminates at the top of the zone, where there is a thick, carious, weathering band, crowded with specimens of *Salterella*, forming a passage bed into the calcareous shales at the base of the Durness dolomites. At one locality near Loch an Nid, Dundonnell Forest, Ross-shire, thin shales, intercalated in the serpulite grit, yielded a fine carapace of *Olenellus Lapworthi*—a form of frequent occurrence in the underlying fucoid beds. Prof. Lapworth recorded the finding of *Orthoceras* and linguloid shells in the top part of this zone at Eireboll.[3]

Immediately above the serpulite grit in Eireboll and Assynt we find a few feet of dark calcareous shale, with iron pyrites, probably deposited at the limit of

[1] Smithsonian Miscell. Collect., vol. lvii., No. 5, p. 125, 1911.
[2] *Ibid.*, No. 3, 1911.
[3] *Geol. Mag.*, vol. x., new series, p. 126, 1883.

sedimentation. This layer, which is singularly devoid of organisms, ushers in the great succession of dolomites and limestones, upwards of 1500 feet in thickness—perhaps the most remarkable type of sedimentation among the Cambrian rocks of the north-west Highlands. The Geological Survey has divided this calcareous sequence into seven well-marked groups, some of which have as yet yielded no fossils beyond worm casts. Attention will presently be directed to the absence of calcareous forms in many of the bands of dolomite and to the probable cause of their disappearance.

The thin calcareous shale just referred to is followed by dark blue dolomite limestone, forming the basal portion of the Ghrudhaidh group. It contains sparsely scattered, well-rounded sand grains, with a bed about three feet thick, near the bottom, charged with *Salterella pulchella* and *S. rugosa*. In the overlying twenty feet of dolomite the sand grains gradually disappear, and the rock assumes a mottled character, due to innumerable worm casts of the *Planolites* type, Here a second layer, yielding *S. pulchella* and *S. rugosa*, supervenes, both forms occurring in the *Olenellus* zone of North America.

The brief summary of the palæontological evidence which has just been given clearly shows that the strata ranging from the middle of the pipe-rock zone to the upper *Salterella* band of the Durness dolomites represent in whole or in part the *Olenellus* zone of North America. Owing to the absence of fossils we have no means of deciding more definitely the base and top of the Lower Cambrian rocks of the north-west Highlands. All the quartzites lying below the middle of the pipe-rock, notwithstanding the absence of zonal forms, have been included in the Lower Cambrian division. This correlation receives some support from the remarkable discovery of Dr. Walcott, who found primitive trilobites several thousand feet beneath the beds yielding *Olenellus Gilberti*, the form closely allied to the Highland trilobites.

On the other hand, when we pass upwards for a certain distance from the *Salterella* bands the evidence is insufficient to establish the stratigraphical horizon of the beds. For in the overlying strata, comprising the remainder of the Ghrudhaidh group, the whole of the Eilean Dubh group, and the lower part of the Sail Mhor group, and consisting of dolomites, limestones, and cherts, with little or no terrigenous material, the only fossils that can be shown to be due to organisms are worm casts of the nature of *Planolites*, although the limestone and chert may have originated from the débris of the calcareous and siliceous organisms of the plankton. A noticeable feature of the Ghrudhaidh and Eilean Dubh groups is the occurrence in them of bands of brecciated dolomite on several horizons, which do not imply any break in the continuous sequence of deposits. The total thickness of this portion of the Durness dolomites and limestones, yielding no fossils beyond worm casts, amounts to 350 feet.

But in the upper part of the Sail Mhor group siliceous and calcareous organisms of a higher grade make their appearance. Among the former we find the *Rhabdaria* of Billings. The calcareous forms are represented by (1) gasteropods, including a single specimen of a murchisonid, two species of a pleurotomarid (*Euconia Ramsayi* and *E. Etna*) of a type occurring in the calciferous rocks of Newfoundland and Canada; (2) cephalopods, comprising two slightly bent forms with closely set septa and wide endogastric siphuncles, showing affinities with those of *Endoceras* and *Piloceras*; (3) arthropods, represented by the epitome of a large asaphoid trilobite resembling that of *Asaphus canalis* of Conrad. This evidence is insufficient to determine the exact horizon of these beds, but clearly indicates that we are no longer dealing with Lower Cambrian strata. The cephalopods are like those found in the Ozarkic division of Ulrich (Upper Cambrian), in North America. According to Schuchert, the cephalopods with closely set septa are of Cambrian type and older than those of the Beekmantown terrane of American geologists. On the other hand, the asaphoid type of trilobite is suggestive of a somewhat higher horizon.

No fossils have been found in the overlying Sangomore group, about 200 feet thick, which consists mainly of granular dolomite, with bands of chert, some being oolitic, together with thin fine-grained limestones near the top.

Above this horizon, at a height of more than 800 feet above the top of the *Olenellus zone*, we encounter the great home of the fossils peculiar to the Durness limestone in the Balnakeil and Croisaphuill groups. The former consists mostly of dark limestones, with nodules of chert, and, with a few alternations, of white limestone bands. A few thin layers are charged with worm casts. The overlying group is more varied, the lower part being composed of dark grey limestones full of worm casts, and with some small chert nodules arranged in lines; the middle portion, of dark granular and unfossiliferous dolomite; and the upper part, of massive sheets of fossiliferous limestone full of worm casts. The total thickness of these two groups in Durness is about 550 feet.

These two subdivisions have yielded more than twenty genera and about one hundred species. In Durness sixty-six species have been obtained from the Balnakeil group alone, fifteen of which have not as yet been found in the overlying Croisaphuill group, thus leaving fifty-one species common to both divisions. The Ben Suardal limestones in Skye, which were mapped by the Geological Survey as one division, are regarded, on palæontological grounds, as the equivalents of both these groups. Owing to the number of species common to both subdivisions, the fauna will be here referred to as a whole.

Both siliceous and calcareous organisms are present in this fauna. Among the former we find *Archaeoscyphia* (Hinde), described by Billings as *Archaeocyathus*, an early Cambrian coral, but shown by Hinde to be a siliceous sponge.[4] The genus *Calathium* is represented by four species. Other genera and species of sponges occur, so that the siliceous nodules, which are very common in both groups, may be in great part due to them. In this connection it may be mentioned that Hinde obtained sponge spicules from some of the nodules. Hinged brachiopods have also been collected from these beds, and include *Nisusia* (*Orthosina*) *festinata*, *N. grandaeva*, and Camarella.

But the characteristic feature of the fauna is the assemblage of calcareous mollusca comprising lamellibranchs, gasteropods, and cephalopods, showing a wide range of variation, and consequently a long ancestry. The lamellibranchs, though represented only by two genera, *Euchasma* and *Eopteria* of Billings, with several intermediate forms, are of extreme interest, as they are only known to occur elsewhere in Newfoundland and eastern Canada. The gasteropods, however, furnish the largest number of species —about 48 per cent. of the whole. The primitive euomphalids, *Maclurea* and *Ophileta*, are most characteristic. The former genus has a large number of species, many of which are to be found in the Beekmantown limestone of Newfoundland and eastern North America. Only one of the species (*Maclurea Peachi*) is peculiar to Durness. Several species of

[4] Quart. Jour. Geol. Soc., vol. xlv., p. 125, 1889

Ophileta are found, some of which likewise occur in the Beekmantown limestone. Euomphalus has also been recorded, while several forms belonging to the nearly allied family of the Turbinidæ, and placed in Lingström's genus *Oriostoma*, are also met with in the Beekmantown limestone.

Murchisonids and Pleurotomarids number twenty-seven species and show a very wide range of variation. The chief subgenera of the former are *Hormotoma* and *Ectomaria*, many species of which occur with remarkable variations. All the types of variation found in Durness are to be found in North America, and several of the species are common to both regions. The pleurotomarids vary in a similar manner, the chief genera being *Raphistoma* and *Euconia*, and a form resembling *Hormotoma*, only with a shorter spire. Species belonging to each of these subgenera are likewise common to both areas, while some are only known from the north-west Highlands.

The cephalopods are of equal interest. They are also of primitive type, and, at the same time, show a wide range in form. The prominent feature in the straighter specimens is the great width of the laterally placed siphuncle, which is generally furnished with endocones and organic deposits. The genus *Piloceras* is the most characteristic type and shows this peculiar feature best. It has only been recorded from Scotland, Newfoundland, Canada, and the eastern States of North America. The following additional genera are represented, viz. *Endoceras*, chiefly by siphuncles in great variety; *Actinoceras*, *Cyrtoceras*, and, doubtfully, *Orthoceras*. Several forms have been attributed to *Orthoceras* which, on re-examination have been found to be the siphuncles of other genera, resembling American types described by Hall and Whitfield.

The whorled nautiloids provisionally classed with the genus *Trocholites* of Conrad are represented by several distinct forms as yet unnamed.

The trilobites are of rare occurrence in these two groups of dolomite and limestone. They are fragmentary and poorly preserved. This is doubtless one of the disappointing features connected with this remarkable assemblage of organic remains, for the presence of a zonal form would have helped to define the horizon of these beds. Only one species, *Bathyrus Nero* (Billings) has been identified, which also occurs in the Beekmantown limestone of Newfoundland. The other trilobite remains, though poorly preserved, leave a Cambrian facies characteristic of North America.

In connection with this fauna certain features have been observed which throw some light on the absence of calcareous organisms from thick zones of the Durness dolomite and limestone. In my detailed description of the palæontology of the Cambrian rocks of the north-west Highlands in the Geological Survey Memoir I stated that "in most cases the septa and walls of chambered shells have been wholly or in part dissolved away, so as to leave only the more massive structures of the siphuncles, and worm castings are often found within the chambers where the septa have been preserved. These features seem to indicate that the accumulation of the calcareous mud in which the fossils were embedded was so slow that there was time for the solution of part of an organism before the whole of it was covered up."[5] There is good reason to believe that many organisms wholly disappeared by this process, so that it is reasonable to conclude that the fossils obtained from the Durness dolomites cannot be regarded as furnishing a complete life-history of the forms that originally existed in that sequence of deposits. Attention has already been directed to the fact that beneath the two subdivisions now under consideration there are groups of dolomite and limestone which so far have yielded no organic remains beyond worm castings. And even in the important Croisaphuill group, with its fossiliferous zones, there are thick groups of dolomite which have furnished no calcareous organic remains. Obviously the palæontological record in this instance is glaringly incomplete, for we have no reason to suppose that the life of the time flourished in some of the calcareous zones and not in others.

The highest subdivision of the Durness limestone, measuring about 150 feet in thickness (Durine group), has yielded two species of *Hormotoma*—viz. *H. gracilis* and *H. gracillima*—both of which occur in the two underlying groups. *H. gracilis* occurs in the Beekmantown, the Chazy, and the Trenton limestones of America.

Before assigning any stratigraphical horizons to the fauna of the Durness dolomites, it is desirable, owing to the American facies of the fossils, to recapitulate the evidence bearing upon the life of Cambrian time in North America. But the Cambrian life-history of Scotland would be incomplete without a brief reference to the recent discovery of fossils along the eastern border of the Highlands.

In 1911 Dr. Campbell announced in *The Geological Magazine* that fossils had been found in the Highland border series north of Stonehaven, and, during this year, Dr. Jehu made a similar discovery in rocks belonging to this series near Aberfoyle. Papers on these subjects will be communicated to this section. For my present purpose it will be sufficient to indicate the nature of the fossils and the lithological characters of the rocks containing them.

The Highland border series north of Stonehaven and near Aberfoyle includes sheared igneous rocks, both lavaform and intrusive, with black shales, cherts, and jaspers. North of Stonehaven the fossils occur in thin, dark, flinty pyritous shale, while at Aberfoyle they have been found in shaly films at the edge of the chert bands. Several years ago radiolaria were detected in the cherts between Aberfoyle and Loch Lomond. From time to time these Highland border rocks have been carefully searched for fossils, but until recently with little success, owing to the intense movement to which they have been subjected, resulting in marked flaser structure in all except the most resistant bands.

The fossils consist chiefly of horny, hingeless brachiopods, phyllocarid crustacea, worm-tubes, and the jaws and chetæ of annelids. The genera of brachiopods comprise *Lingulella*, *Obolus*, *Obolella*, *Acrotreta*, and *Linarssonia*. The association of these brachiopods with phyllocarid crustaceans resembling *Hymenocaris* and *Lingulocaris* is suggestive of an Upper Cambrian horizon—an inference which is supported by the absence of graptolites.

In the published Geological Survey maps these Highland border rocks are queried as of Lower Silurian age. This correlation was based partly on their resemblance to the Arenig volcanic rocks and radiolarian cherts of the Southern Uplands, and partly because, as shown by Mr. Barrow, they are overlain by an unconformable group of sediments, termed by him the Margie series. The cherts, the green schists, and the Margie series have shared in a common system of folding, and are unconformably surmounted by Downtonian strata near Stonehaven. Though the original correlation may not be strictly correct, it is probable, in my opinion, that representatives of both the Arenig and Upper Cambrian formations may occur in the Highland border series, and, further, that Upper Cambrian strata may yet be found in the Girvan area, as originally suggested by Professor Lapworth in correspondence with Dr. Horne.

[5] "Geological Structure of the North-west Highlands," Geol. Sur. Mem., 1907, p. 380.

The Cambrian Fauna of North America.

The classification of the Cambrian fauna found in North America is based on the researches of a band of distinguished palæontologists, comprising among the older investigators Billings, Hall, and Whitfield, and among modern workers Walcott, Ulrich, Schuchert, Brainerd, Seely, Ruedemann, Matthew, Clarke, and Grabau. Prominent among these investigators stands Dr. Walcott, alike for his original and exhaustive contributions to this branch of inquiry and for his complete mastery of the sequence and distribution of life in Cambrian time in North America. Indeed, geologists all over the world owe him a deep debt of gratitude for the services which he has rendered to Cambrian palæontology.

Throughout the greater part of Cambrian time there existed in North America two distinct life provinces. The eastern one ran along the Atlantic coast from the north of Newfoundland to a point south of New York, extending only a short distance inland, with a faunal facies resembling that of north-west Europe, exclusive of the north-west Highlands of Scotland. The western province lay to the north-west of that just described, and ranged from northern Newfoundland, south-westwards to Central North America and the Pacific Ocean. On the east side of the Rocky Mountains it swept northwards to British Columbia, perhaps as far as the Arctic Ocean. The remarkable feature of the life of the western province is its essentially American facies.

Geologists are familiar with the triple classification of the Cambrian system by means of the trilobites in North America, as in Europe. The Lower Cambrian division represents the *Olenellus* epoch of Walcott, characterised by some form of Olenellid, or, to use the name now given to the family by that investigator, the *Mesonacidae*. The western life-province contains the true *Olenellus* of which *O. Thompsoni* is the type. The strata yielding this fauna extend over such a wide area of North America that within this same province we find a western and an eastern facies. The western facies is found in Nevada and California, where *Olenellus* is represented by such specific forms as *O. Gilberti* and *O. Freemonti*. But it is noteworthy that these forms occur near the top of the Lower Cambrian series, and are soon followed by *Zacanthoides* and *Crepicephalus*, trilobites of Middle Cambrian affinities. Towards the lower part of the sequence of deposits, which there consist mainly of limestone, and extend downwards for a distance of more than 4000 feet beneath the beds containing the true *Olenellus*, Walcott found specimens of *Holmia Rowei* and *Nevadia Weeksi*. The latter form is regarded by him as the most primitive of all the *Mesonacidae* yet known. Near the base the limestones have yielded the primitive corals, *Archaeocyathus* and *Ethmophyllum*; and the brachiopods *Mickwitzia* and *Trematobolus*. The other forms found on this horizon belong to the following genera: (trilobites) *Protypus* and *Microdiscus* (brachiopods) *Kutorgina*, *Swantonia*, *Nisusia*, *Billingsella*, and (tubicolar annelids) *Hyolithellus* and *Salterella*. The eastern facies of the western life-province is best known from the region of Georgia, in Vermont. It is the home of the type species of *Olenellus* (*O. Thompsoni*). It is associated with *Mesonacis vermontana*, which has now given the name to the whole family, with *Elliptocephalus asaphoides*, one of the earliest known trilobites of the family, and with other forms such as *Bathynotus*, *Holopygia*, *Protypus*, and *Microdiscus*. The tubicolar worms are represented by *Hyolithellus* and *Salterella*, the brachiopods by *Nisusia*, *Swantonia*, *Kutorgina cingulata*, and *Paterina labradorica*. There can be no doubt that the assemblage of organic remains found in this Georgian terrane is merely the counterpart of that found in the *Olenellus* zone of the north-west Highlands.

Proceeding now to the eastern life-province, we find that the Lower Cambrian rocks are characterised by the trilobite genus *Callavia*, belonging to the family of the *Mesonacidæ*, and bearing a close resemblance both to *Holmia* and *Nevadia*. In southern Newfoundland two species of *Callavia* occur, of which *C. Bröggeri* is the type. It is accompanied by *Microdiscus*, *Hyolithellus*, *Paterina labradorica*, and *Helenia bella*. In New Brunswick the *Protolenus* fauna, with *Protolenus* as the characteristic trilobite, probably represents the upper part of the *Olenellus* zone. In this connection the recent discovery of the *Protolenus* fauna by Mr. Cobbold, in Shropshire, in strata associated with *Callavia*, and overlain by beds yielding *Paradoxides*, is of special importance, as it shows the close relation between the Lower Cambrian fauna of Wales and that of the Atlantic or eastern province of North America.[6]

The Middle Cambrian division of the western life-province is characterised chiefly by the trilobite genus *Olenoides*; indeed, the western part of it is the home of *Olenoides* and the large-tailed trilobites. The characteristic genera of this group to be found in that region are *Kootenia*, *Zacanthoides*, *Bathyuriscus*, *Asaphiscus*, *Neolenus*, *Dorypygella*, *Dorypyge*, *Damesella*, and *Ogygopsis*.

In this region the Middle Cambrian limestones and shales occurring on Mount Stephen, in British Columbia, have yielded a magnificent series of trilobites, eurypterids, limuloids, crustacea ranging from congeners of the brine shrimps to phyllocarid nebalids, annelids belonging to most of the still extant families, holothurians, medusae, and other organic remains. For the most part many of these forms are so fragile that only their tracks remain as indications of their existence in palæozoic deposits. Not till we reach the Solenhofen slates in Jurassic time do we find similar favourable conditions for the entombment and preservation of their highly modified successors. The remarkable evidence bearing on the evolution of groups of organisms furnished by this assemblage of fossils from Mount Stephen has been admirably described and illustrated by Walcott in his series of papers published in the Smithsonian Miscellaneous Collections.

In the New Brunswick portion of the eastern or Atlantic life-province the strata yielding *Paradoxides* follow those bearing the *Protolenus* fauna. Six species of Paradoxides have been obtained from this horizon, including *P. davidis*, together with the following genera: *Agnostus*, *Agraulos*, *Liostracus*, *Conocoryphe*, and *Ctenicephalus*. Schuchert points out that this fauna is "closely allied to the *Paradoxides* faunas of Wales and Sweden, but less so with that of Bohemia."[7]

In southern Newfoundland Walcott showed that the base of the Middle Cambrian division is marked in Manuel's Brook by a conglomerate containing fossils of the lower or Georgian terrane, thus indicating elevation and erosion of the Lower Cambrian rocks. Higher up the strata yielded *Paradoxides davidis* and *P. bennetti*.

Important evidence pointing to the conclusion that the *Paradoxides* fauna of the eastern or Atlantic province encroached to some extent on the eastern part of the western life-province has been obtained by Walcott at St. Albans, Vermont. But the suggestion has been made by Schuchert that their present position is there due to north-westerly thrusting.[8]

6 Quart. Jour. Geol. Soc., vol. lxvii., p. 296. 1911.
7 Bull. Geol. Soc. of Amer., vol. xx. (1910), p. 522.
8 *Ibid.*

It should be borne in mind that in Middle Cambrian time the eastern and western parts of the western life-province were evidently separated from each other by a land barrier, owing to crustal movement, which was probably connected with the elevation of the Lower Cambrian rocks in the region where they were subjected to erosion.

In the upper division of the Cambrian system in North America there is a marked change in the fauna. Its characteristic features are thus clearly summarised by Schuchert: "In a general way it may be said that the Ozarkic period of Ulrich (Upper Cambrian) begins with the trilobite genus *Dikelocephalus* and the first distinct molluscan fauna. . . . The trilobites and inarticulate brachiopods (greatly reduced in species) are still Cambrian in aspect, while the new faunal feature consists in a rapid evolution, in form and size, of the coiled gasteropods, and of both straight and coiled cephalopods. The latter are distinguished from those of subsequent periods by the exceedingly close arrangement of the septa."[9]

The distinctive trilobite genus of the Upper Cambrian strata of the western life-province is *Dikelocephalus*, where it is associated with an American facies of fossils. The eastern or Atlantic province is characterised by Olenids, though *Dikelocephalus* also occurs, and by typical European forms. In Minnesota and Wisconsin, where the strata consist of sandstones, dolomites, and shales, two species of *Dikelocephalus* have been obtained, together with other genera of trilobites such as *Agnostus* and *Illaenurus;* the limuloid *Aglaspis*; and the gasteropods *Holopea*, *Ophileta*, and *Raphistoma*.

In certain areas this period is characterised by a great succession of calcareous deposits, comprising parts of the Shenandoah limestone and Kittatinny dolomite in New Jersey, portions of the Knox dolomite in Tennessee, and of the dolomite and limestone in Oklahoma. In some of these localities, at least, the lower portions of this calcareous series are grouped with the Upper Cambrian sediments, while the upper parts are classed with Lower Silurian or Ordovician strata. The researches of American palæontologists have shown that in certain areas there is a mixed Cambrian and Ordovician fauna in some of the beds, as in the Tremadoc rocks of Wales. This commingling of faunas is exemplified in the case of the Beekmantown limestone, which is grouped with the Ordovician (Lower Silurian) rocks by most American geologists. Ulrich and Schuchert, on the other hand, regard it as a formation (the Canadic) distinct from the overlying Ordovician system.

The type areas of the Beekmantown limestone are Lake Champlain, the Mingan Islands, and Newfoundland, where the strata consist mainly of a succession of limestones and dolomites more than 1000 feet thick. The fossils are chiefly molluscan, comprising lamellibranchs, gasteropods, and cephalopods. The lamellibranchs are represented, among others, by the genera *Euchasma* and *Eopteria*; the gasteropods by *Ophileta, Maclurea, Euomphalus, Holopea, Hormotoma, Ectomaria, Murchisonia, Lophospira, Euconia, Raphistoma, Helicotoma*; the cephalopods by *Orthoceras, Cyrtoceras, Gomphoceras, Piloceras, Trocholites*. Of the foregoing genera many of the species are common to this region and the north-west Highlands of Scotland.

The trilobites associated with this fauna comprise the genera *Dikelocephalus, Bathyrus, Asaphus, Harpes*, and *Nileus*.

In northern Newfoundland, in zones F to N of Billings, this fauna, with localised species, is found in great development in limestones and dolomites resembling those of Durness. Its upper limit is there clearly defined, for the limestones and dolomites are overlain by dark shales containing graptolites of undoubted Arenig age.

A careful comparison of the faunas of the Durness and Beekmantown limestones shows that the assemblage of fossils in the Balnakeil and Croisaphuill groups of Durness is practically identical with that in the zones F to N of Billings, as developed in Newfoundland. These groups must therefore be older than the Arenig rocks of Wales, and must represent at least the Welsh Tremadoc strata, if not part of the Lingula Flags, both of which, according to the English classification, are grouped with the Cambrian system.

But even in the purely European province of North America, in New Brunswick, where the Beekmantown calcareous fauna is entirely absent, and where the faunal sequence and type of sedimentation are almost identical with those of North Wales, the basal Ordovician or Lower Silurian rocks of American geologists include the *Peltura scarabaeoides* and the *Parabolina spinulosa* zones, which, in Wales, are classed with the Lingula Flags. It is obvious, therefore, that the boundary-line between the Cambrian and Ordovician (Lower Silurian) systems is not drawn at the same stratigraphical horizon by American and British geologists. In fixing the age of the Durness dolomites and limestones the English classification has been adopted.

The palæontological evidence now adduced regarding the relation of the Cambrian fauna of the north-west Highlands to that of North America leads to the following conclusions:—

1. The Lower Cambrian fauna of the north-west Highlands, distinguished by the genus *Olenellus* and its associates, is almost identical in character with that of the Georgian terrane of the western life-province of North America, and essentially different from the Lower Cambrian fauna of the rest of Europe.

2. No forms characteristic of the Middle Cambrian division, either of Europe or North America, have as yet been found in the north-west Highlands; but this division may be represented by the unfossiliferous dolomites and limestones of the Ghrudhaidh, Eilean Dubh, and the lower Sail Mhor groups.

3. The fossiliferous bands of the Sail Mhor group may be the equivalents of the lower part of the Upper Cambrian formation.

4. The Balnakeil and Croisaphuill groups of the Durness dolomites and limestones contain a typical development of the molluscan fauna of the Beekmantown limestone, belonging to the western life-province of North America. As the Beekmantown limestone is succeeded by shales, with Arenig graptolites, it follows, in accordance with British classification, that these groups must be of Upper Cambrian age.

5. The highest subdivision of the Durness limestone (Durine) has not yielded fossils of zonal value, and the members of this group are not overlain in normal sequence by graptolite-bearing shale or other sediments.

Cambrian Palaeogeography between North America and North-West Europe.

In attempting to restore in outline the distribution of land and sea in Cambrian time between North America and north-west Europe reference must be made to various investigators whose researches in palaeogeography are more or less familiar to geologists. Among these may be mentioned Suess, Dana, De Lapparent, Frech, Walcott, Ulrich, Schuchert, Bailey Willis, Grabau, Hull, and Jukes Browne. The

[9] *Op. cit.*, p. 524.

views now presented seem to me to be reasonable inferences from the palæontological evidence set forth in this address.

In the north-west Highlands there is still a remnant of the old land surface upon which the Torridonian sediments were laid down. There is conclusive evidence that the pre-Torridonian land was one of high relief. As the Torridonian sediments form part of a continental deposit it may be inferred that the Archæan rocks had a great extension in a north-westerly direction. The increasing coarseness of the deposits towards the north-west suggests that the land may have become more elevated in that direction. At any rate, the pile of Torridonian sediments points to a subsidence of the region towards the south-east, and probably to a correlative movement of elevation towards the north-west.

The sparagmite of Scandinavia is an arkose resembling the dominant type of the Torridon sandstone; is of the same general age, and has evidently been derived from similar sources in the Scandinavian shield. In eastern North America coarse sedimentary deposits form part of the newer Algonkian rocks, which are still to be found rising from underneath the Cambrian strata in the region of the great lakes. These materials were obtained from the great Canadian shield, which must have formed a large continental area during their deposition.

It is reasonable to infer that these isolated relics of old land surfaces were united in pre-Torridonian time, thus forming a continuous belt from Scandinavia to North America. During the period which elapsed between the deposition of the Torridon sandstone and the basement members of the Cambrian system a geosyncline was established which gave rise to a submarine trough, trending in an east-north-east and west-south-west direction, both in the British and North American areas. In the latter region it extends from Newfoundland to Alabama, its south-eastern limit being defined by the old land surface of Appalachia. The extension of this Appalachian land area in a north-east direction beyond the limits of Nova Scotia and Newfoundland was postulated by Dana and other American writers. This geosyncline remained a line of weakness throughout palæozoic time, both in Britain and North America, which resulted in the Caledonian system of folding in Britain, and in the Taconic, Appalachian, and Pennsylvanian systems in North America. Hence it is manifest that the original shore-lines of this trough are now much nearer each other than they were in Cambrian time.

The Cambrian rocks of the north-west Highlands were laid down along the north-west side of this trough during a period of subsidence, for the great succession of Durness dolomite and limestone, with little or no terrigenous material, is superimposed on the coarser sediments of that formation. On the other hand, the Cambrian strata of Wales seem to have been deposited along the southern limit of this marine depression. The Archæan rocks that now constitute the central plateau of France may have formed part of its southern boundary. The extension of this land area towards the north-east may have given rise to the barrier that separated the Baltic life-province from that of Bohemia, Sardinia, and Spain. In my opinion this southern land area in Western Europe was continuous across the Atlantic with Appalachia. For the life sequence found in the Cambrian rocks of New Brunswick is practically identical with that of Wales and the Baltic provinces, thus showing that there must have been continuous intercourse between these areas. Along this shore-line the migration of forms seems to have been from Europe towards America. On the other hand, along the northern shore the tide of migration seems to have advanced from America towards the north-west Highlands. The question naturally arises, what cause prevented the migration of the forms from one shore of this trough to the other? American geologists are of opinion that this is probably due to the existence of land barriers; but, in my opinion, it can be more satisfactorily accounted for by clear and open sea, aided by currents.

The south-western extremity of the American trough in Lower Cambrian time opened out into the Mississippian sea, which was connected with the Pacific Ocean, and stretched northwards towards the Arctic regions. Reference has already been made to Walcott's discovery in Nevada of the primitive trilobite *Nevadia Weeksi*, from which he derives both branches of the *Mesonacidae*, one branch linking *Nevadia*, through *Callavia*, *Holmia*, and *Wanneria*, with *Paradoxides*, the other connecting *Nevadia* with *Olenellus*, through *Mesonacis*, *Elliptocephalus* and *Paedumias*.

In Nevada the genus *Holmia*, as already shown, is associated with the primitive type *Nevadia*. *Wanneria* is found in Nevada, in Alabama, and in Pennsylvania, thus showing that this genus is common to the Missisippian sea and to the long trough north-east of Alabama. *Mesonacis* has been obtained in the submarine depression at Lake Champlain, at Bonne Bay, Newfoundand, and at the north side of the Straits of Belle Isle. *Elliptocephalus* has been recorded from the New York State. *Olenellus* has been found in Nevada, in Vermont, and in the north-west Highlands. All the genera now referred to may have migrated along the north-western shore of this trough.

As regards the distribution of the genus *Callavia*, this form has been met with in Maine, in Newfoundland, and in derived pebbles in a conglomerate in Quebec. Two species have been recorded in Shropshire. These forms probably moved along the southern shore of this sea from Wales to North America.

Reference has already been made to the fact that, in the interval between Lower and Middle Cambrian time, in certain areas in North America the Lower Cambrian rocks were locally elevated and subjected to erosion. During this interval the southern end of the trough seems to have had no connection with the Mississippian sea, for in Middle Cambrian time, as already indicated, the *Paradoxides* fauna is found in the trough on the east side of North America, whereas on the west side it is represented by the *Olenoides* fauna.

In Upper Cambrian time a great transgression of the sea towards the north supervened. The *Dikelocephalus* fauna is found on both sides of America, thus showing that the previous land barrier had been submerged. While this genus occurs in Wales and the Baltic provinces, it has not as yet been recorded from the north-west Highlands, but I quite expect that this discovery may be made at some future time.

Along the northern side of the American trough clear water conditions prevailed, owing to the northward recession of the shore-line, which led to the accumulation of a great succession of calcareous deposits, including the Beekmantown limestone, to which reference has already been made. Schuchert, as already stated, has pointed out that, in the lower part of the Ozarkic (Upper Cambrian) system, in Minnesota and Wisconsin, the gasteropod genera *Hoopea*, *Ophileta*, and *Raphistoma* are associated with two species of *Dikelocephalus*. This molluscan fauna is evidently the precursor of that of the Beekmantown limestone. It was probably from this central region of America that the calcareous fauna of Beekmantown migrated to the submarine trough in the typical Champlain region, and through Newfoundland to the north-west Highlands of Scotland.

The section at St. John, New Brunswick, where the Baltic and Welsh types of the *Olenus* fauna occurs, shows that the southern shore line of the trough must then have occupied much the same relative position as in Lower and Middle Cambrian time. In the same region the strata containing this fauna, with *Peltura scarabaeoides* and *Dictyonema flabelliforme*, are overlain by dark shales with Arenig graptolites. These graptolite-bearing terrigenous deposits eventually extended across the trough northwards, until, in Newfoundland, they came to rest on the Beekmantown limestones.

In the Lake Champlain region, in the Chazy limestone, which there immediately succeeds the Beekmantown limestone without the intervention of the Arenig graptolite shale, there is a survival of the Beekmantown molluscan fauna with only such slight modifications as to indicate genetic descent. In the same trough the descendants of this fauna are to be found in the Trenton limestone.

In this connection it is worthy of note that the molluscan fauna and the corals of the Stinchar and Craighead limestones of Upper Llandeilo age in the Girvan district of the Southern Uplands have an American facies, as first suggested by Nicholson. The appearance of American types in these limestones may be accounted for in the following manner: attention has already been directed to the divergent types of sedimentation presented by the Upper Cambrian strata of the north-west Highlands, and of the south-east Highlands, at Stonehaven and Aberfoyle. In the former case there is a continuous sequence of dolomites and limestones, while in the latter we find a group, comprising radiolarian cherts and black shales, associated with pillowy spilitic lavas and intrusive igneous rocks, indicating conditions of deposition at or near the limit of sedimentation. But, notwithstanding the different types of sedimentation and the divergent faunas in the two areas, I believe that during the Upper Cambrian period, and probably for some time thereafter, continuous sea extended from the north-west Highlands to beyond the eastern Highland border. The Upper Cambrian terrigenous sediments which we now find at Stonehaven and Aberfoyle must have been derived from land to the south. In Llandeilo time the Arenig and Lower Llandeilo rocks of the Girvan area were elevated and subjected to extensive denudation. On this highly eroded platform, as first proved by Prof. Lapworth, coarse conglomerates, composed of the underlying materials, were laid down in association with the Stinchar and Craighead limestones. In my opinion the appearance of the American forms in these limestones is connected with the movement that produced this unconformability in the Girvan area. This local elevation was probably associated in some form with the great crustal movements that culminated in the overthrust of the north-west Highlands and caused the intense folding and flaser structure of the rocks along the Highland border. By these movements shore-lines may have been established between the north side of the old Palæozoic sea and the Girvan area, which permitted the southern migration of the American forms.

Note.—Since writing the above my attention has been directed to the recent work of Bassler on "The Early Palæozoic Bryozoa of the Baltic Provinces," published by the Smithsonian Institution in 1911. In his introduction the author has shown that the Ordovician (Lower Silurian) and Gothlandian (Upper Silurian) rocks of the Baltic provinces contain a larger percentage of bryozoan species, in common with the Black River, Trenton, and Niagara limestones of the same relative age in eastern North America. This fact suggests that during Lower and Upper Silurian time the old lines of migration were still open, and that the Bryozoa, being of clear-water habit, were able to cross the old trough from side to side.

NOTES.

FROM a Press cutting just received from Sydney we learn that Mr. Fisher, Prime Minister, Australia, referred to the forthcoming visit of the British Association in 1914 in his Budget speech on August 1. He said:—"We have been advised that about half as many more members of that association are likely to visit the Commonwealth than was anticipated when our invitation was accepted. This will entail an increase in the amount of money which I propose to give towards their expenses; and, speaking for this Parliament and country, I say that no greater compliment could be paid to Australia than the fact that our visitors are to be increased in number. It is usual a year or eighteen months before the visit is made to send a representative man of the same class as themselves to get into communication with them. We propose to incur that expenditure pending the expenditure of a larger amount to cover their expenses."

THE Chancellor of the Royal Prussian Ordre pour le Mérite has, through the German Embassy, informed Sir William Turner, K.C.B., F.R.S., vice-chancellor and principal of the University of Edinburgh, that the German Emperor has appointed him to be knight of the Order in the department of science. The number of those on whom this Order is conferred is strictly limited, and since 1885, when Lord Lister was appointed, Sir John Murray, Sir Joseph D. Hooker, Lord Avebury, Lord Rayleigh, the Right Hon. James Bryce, Sir David Gill, and Sir Wm. Ramsay have been its recipients. The death of Lord Lister having caused a vacancy, his Majesty the Emperor has been pleased to confer the Order on Sir Wm. Turner, in recognition of the contributions which he has made to anatomical science.

THE fourteenth meeting of the Australasian Association for the Advancement of Science will be held in Melbourne in January, 1913.

THE Royal Aero Club has decided to award its gold medal to Mr. S. F. Cody in recognition of his victory in the recent War Office aeroplane trials.

MR. T. H. MOTTRAM has been appointed to succeed the late Mr. Pickering as divisional inspector of mines in charge of the Yorkshire and North Midlands District. Mr. J. R. Wilson, of Leeds, will fill the position vacated by Mr. Mottram.

WE regret to see the announcement of the death, on September 4, of Dr. Stanley Dunkerley, formerly professor of engineering, Manchester University, and the Royal Naval College, Greenwich, and the author of a standard work on "Hydraulics."

THE departmental committee appointed by the Home Office to consider the best methods of testing miners' safety lamps reports that the official tests for flame safety lamps should be mechanical and photometric, and should be made by means of an explosive mixture. For the mechanical test they suggest that a lamp should be dropped from a height of 6 ft. on a wooden floor.

THE annual general meeting of the Society of Chemical Industry was held in New York last week under the presidency of Dr. R. Messel, F.R.S. The society's medal, awarded once in every two years for conspicuous service rendered to applied chemistry by research, discovery, invention, or improvements in processes, has this year been awarded to Sir William Crookes, O.M., F.R.S., for his discoveries in physical chemistry and the rare metals. It has been decided to hold the next annual meeting of the society in Liverpool.

ACCORDING to *The Lancet*, the following sums have been bequeathed by Madame Jonglart for the furtherance of science in France:—50,000 francs to the Collège de France; 95,000 francs to the faculty of science of the Sorbonne, of which amount 55,000 francs is to be devoted to the zoological laboratory; 95,000 francs to the museum; 50,000 francs to the Faculty of Medicine; 70,000 francs to the School of Advanced Studies; 150,000 francs to be divided between the Geographical and Anthropological Societies and the Association for the Advancement of Science, and 139,000 francs to various scientific and charitable institutions.

THE Board of Agriculture and Fisheries desires to direct attention to the fact that the employment, from time to time, in the newspaper Press and elsewhere, of the phrase "cattle plague" in connection with the recent outbreaks of foot-and-mouth disease in this country has given rise to considerable apprehension in Continental countries, and is calculated to be prejudicial to the interests of British stockowners. The Board wishes, therefore, specifically to state that no case of cattle plague (*Peste bovine, Rinderpest*) has recently occurred in the United Kingdom, which has been absolutely free from that disease since the year 1877, that is for more than thirty-five years past.

BY the will of Mr. A. O. Hume, C.B., an obituary notice of whom appeared in our issue of August 8, his collection of heads and horns of Asiatic and other animals is left to the trustees of the British Museum, provided that an undertaking be given by the trustees that the collection be preserved in an undivided condition. The testator confirmed a settlement dated January 10, 1907, by which he gave a sum of 10,000*l*. Two-and-a-Half per Cent. Consolidated Stock for the endowment of the South London Botanical Institute, and also the provisions of an indenture dated September 29, 1911, by which he gave his premises, 323, Norwood Road, for the purposes of the institute, and he left all his botanical books and books on ornithology and dictionaries upon trust for the institute, to encourage the study of botany (especially British botany) in the county of London south of the River Thames, and also all parts of his herbaria not already transferred to the institute. Subject to the payment of certain annuities, Mr. Hume left the residue of his property to the South London Botanical Institute.

THE council of the Institute of Chemistry is making an endeavour to raise a fund for new buildings for the institute. There can be no doubt that the institute has steadily raised the standard of education in chemical science in the British Empire, and by its means the practice of chemistry, as a profession, has become firmly established and honourably maintained for the public good. From a perusal of the papers relating to the appeal issued to the fellows and associates, it appears that owing to alterations which the London County Council propose to carry out by the widening of Southampton Row, at the rear of the present premises of the institute, 30 Bloomsbury Square, it will not be possible to effect a renewal of the present lease. The council of the institute wishes, therefore, to take this opportunity to secure more suitable and permanent headquarters. It is reckoned that with real economy, adequate provision for the work of the institute can be obtained for about 15,000*l*. The appeal has now been issued nearly three years, and the amount promised to date is about 10,000*l*. As the council will proceed to select a site and prepare plans at the close of this year, it is very desirous of being assured that the full sum of 15,000*l*. will be available, and it is hoped, therefore, to raise the 5000*l*. which is still required before the end of October. Contributions may be forwarded to the president at 30 Bloomsbury Square, London, W.C., or may be sent direct to the account of the Institute of Chemistry (Buildings Fund), with the London County and Westminster Bank, Ltd., 214 High Holborn, London, W.C.

IN the September issue of *Man* Mr. A. R. Brown has compiled from his own personal knowledge and information gathered from some published literature a useful map of Western Australia, showing the distribution of several of the native tribes. The map also marks the division between the tribes which practise circumcision and subincision on the east, and those on the west among whom these rites are unknown.

MAJOR A. J. N. TREMEARNE publishes in the September issue of *Man* selections from a diary written in the years 1843–48 by his great-uncle, the late Rev. John Martin, a Wesleyan missionary to the West Coast of Africa, which possess a special interest because they supply a record of a remarkable type of fetish practices before anthropologists had begun to interest themselves in such matters. The natives in his day, he says, had some confused ideas about metempsychosis, which to a reader of our time suggests totemism. Thus, when a child was carried off by a wild beast, it was believed that some deceased member of the family, annoyed at the neglect of his relatives, had entered the animal and caused the attack, and for this reason they would not kill such animals. The living sacred snake, Dagwe or Dagbi, used to get loose, enter houses and kill poultry until he was finally captured by his priest. The insolent and outrageous conduct of the fetish priests and priestesses during their processions through the towns is specially noteworthy.

THE Field Museum established at Chicago in 1893 has issued a well-illustrated catalogue of a valuable collection of antiquities from Boscoreale, in South

Italy, which has been recently presented. It is the work of Mr. De Cou, who was killed by Arabs while conducting excavations at Cyrene in north Africa in March, 1911. Mr. Tarbell, professor of classical archæology at Chicago, has now edited the work of his friend, with some additions. Nearly the whole collection comes from a villa at the foot of Mount Vesuvius which shared the fate of Pompeii in the eruption of 79 A.D. It contains some curious frescoes and a number of bronze articles, of which the most remarkable is a fine bronze table, the legs shaped in the form of a lion's feet. This was found in a room with the skeletons of two men and a woman, who had apparently perished in the attempt to remove to safety the more valuable property of the house. Two bronze bathing-tubs, which have counterparts in the Naples Museum from Pompeii, are interesting on account of their comparative rarity.

THE movement in favour of the protection and conservation of scenery, antiquities, and the native flora and fauna has made considerable progress in Germany and Switzerland, as well as in other parts of the Continent, during the last few years. A recent number of the *Naturwissenschaftliche Wochenschrift* (No. 27, 1912) is occupied by a series of four articles dealing with the scenic, geological, botanical, and zoological aspects of the question, and contributed by Profs. W. Bock, F. Wahnschaffe, P. Graebner, and M. Braess respectively. In each case the writer describes, with numerous concrete examples, the melancholy results of various acts of vandalism and destruction—the spoiling of otherwise beautiful scenery by huge advertisement hoardings, the erection of painfully conspicuous buildings on hillsides and on the shores of lakes, the conversion of fine lakes into unsightly marshes owing to the construction of waterworks in the neighbourhood, the building over of interesting or even unique geological outcrops, the rooting-up of rare plants, the threatened extinction of rare animals, &c. Righteous indignation is expressed at the wanton or careless mischief done by those responsible for such acts; but it is gratifying to note that vigorous steps are being taken by the State and by private organisations to protect beautiful and interesting natural objects, animate and inanimate, from continued vandalism, and to undo wherever possible the harm already done.

AN article in *The Scientific American* of August 10 discusses the proposal of Prof. Etchegoyen to flood a portion of the Sahara with sea-water by means of a channel from the Mediterranean and thereby to create an inland sea, which, as he claims, would favourably affect the climate, make for conditions of fertility, and for possibilities of colonisation, and provide a channel of communication. Quite apart from the possibility or desirability of the scheme itself, a considerable number of crimes seem to have been committed in the name of physical geography by opponents of the scheme, who have foreseen that the new subtropical area thus created would so far affect the climate of more northern lands as to bring the arctic belt southward to Denmark, and they even seriously discuss the probability of the upsetting of the earth's equilibrium by the displacement of so great a body of sea-water. The writer of the article is at pains to calm these fears, shows that the total area of the Sahara capable of flooding from the sea is no large proportion of the whole, and appears to welcome the idea as much for its own romantic sake as for any benefits which it might confer. He is not concerned to remark upon the ultimate condition of a practically stagnant pond of sea-water, with only a long narrow channel connecting it with the general marine circulation.

THE second volume of Dr. G. Linck's "Fortschritte der Mineralogie, Kristallographie und Petrographie" is now issued (Jena: G. Fischer, 1912. Price 10.50 marks). This annual of the German Mineralogical Society contains original memoirs, and also useful reviews of current work, in which a number of papers are brought together and compared. J. H. L. Vogt (p. 24) summarises his views on the production of ore-deposits by magmatic differentiation; A. Ritzel (p. 62) treats of plasticity in crystals; and both these papers have considerable geological interest. H. Stremme (p. 87) discusses what is known as to the chemistry of kaolin, and papers follow on petrography and on meteorites. The aim of the publication, like that of the *Geologische Rundschau*, is to correlate recent work in the interests of those engaged in teaching and research. The individuality imparted by the authors to their reviews makes an annual of this type far more interesting than a collection of ordinary abstracts.

DISEASES of the respiratory and digestive organs among apes and monkeys in confinement are discussed by Mr. W. R. Blair in vol. i., No. 9, of *Zoologica*. Among other items in the report, it may be noted that orang-utans and chimpanzees in the New York Gardens were infected in 1901 by an outbreak of ulcerating dysentery due to the presence of *Balantidium coli*. The source of the infection was traced to Galapagos giant tortoises in an adjacent enclosure, the colons of which swarmed with the parasite, although the health of the reptiles was unaffected.

DR. ANNANDALE has sent us a copy of the report of a lecture on recent advances in our knowledge of the fresh-water fauna of India, published in vol. viii. of the Journal and Proceedings of the Asiatic Society of Bengal. During the last five years Dr. Annandale has devoted great attention to this fauna, with special regard to the biological relations between different groups of fresh-water organisms, seasonal changes in the life-cycles of the lower invertebrates, and the effect of environment on sponges and other plastic groups. The geographical distribution of the fresh-water fauna as a whole is reserved for future investigation.

SELF-FERTILISATION in the fresh-water snail *Limnaea columella* forms the subject of an article by Mr. H. S. Colton in the May issue of the Proceedings of the Philadelphia Academy. As the result of investigation, it appears that the eggs, when isolated, are self-fertilised, and that the generation-period lasts only two or three months. When more than one species of pond-snail inhabit the same area, hybridisation may occur. *L. columella* seems to present some of the factors necessary for the investigation of a "pure-line" development, that is to say, a line formed by the descendants of a single "homozygotic" organism propagating by self-fertilisation.

THE annual report of the Marine Biological Association of the West of Scotland for 1911 shows that the marine station at Millport is being more largely used by competent investigators, and the amount of first-class scientific work which is being carried out is highly creditable to those who have charge of its organisation. The report contains summaries of the work of Dr. J. F. Gemmill on the anatomy and development of starfishes, of Prof. MacBride's researches on Echinus and Echinocardium and their hybrids, and of Dr. Valentin Dogiel's studies on the development of Pycnogonida. The most unsatisfactory feature of the report is the statement that the steam yacht *Mermaid* has been laid up from want of funds to run her. The use of an adequate steamboat for collecting work is a matter of vital importance to every marine station, and it is to be hoped that in such a wealthy district as that in which the station is situated this defect may soon be remedied by local enterprise.

To the *Naturwissenschaftliche Wochenschrift* of August 18, 1912, Dr. O. Antonius contributes an article on the tarpan of eastern Europe and its relationship to the wild Mongolian horse. The wild horses seen by Pallas in some part of Mongolia are considered to represent a race of the latter; the name *Equus ferus*, Pallas (shown by Mr. Lydekker to be invalid), being adopted for the Mongolian horse, which Hamilton Smith identified years ago as the true tarpan, although this is not referred to by the author. On the other hand, the Russian tarpans obtained in 1853, 1862, and 1866, and described by Schatilow and Radde, are regarded as a truly wild and distinct species, for which the name *E. gmelini* is proposed. The third of these, which was gelded soon after its capture, was acquired in 1884 by the Zoological Gardens at Moscow, where it died a few years later, and was the last representative of its kind. It may be added that these Russian tarpans are generally regarded as half-breds, to which category belongs the animal figured by the author as Przewalski's horse of Mongolia. The domesticated ponies of Bosnia are considered to represent the tarpan type.

THE fifth volume of Notes from the Royal Botanic Garden, Edinburgh, has just been completed by the issue of part xxv., containing an index to the volume and various items of information concerning the garden, together with a somewhat bald key-plan—plenty of blank space is left which might with advantage be utilised in indicating the outdoor plants grown in the garden, as is done in the case of Kew. The most important contents of the present volume are the articles dealing with the plants, including many new species, collected by George Forrest in Yunnan and Eastern Tibet, and described by various distinguished systematists.

THE seismological observatory of Rocca di Papa, near Rome, is one of the oldest in Italy. That it is also one of the most efficient is shown by the summary of the records of the last twelve years recently issued by the director, Dr. G. Agamennone, and his assistant, Mr. A. Cavasino. From this it appears that the average yearly number of earthquakes recorded is 186. Of these, 44, or one-quarter of the total number, originated at distances of less than 100 km., the extinct Latial volcanoes being the seat of a considerable number; while 85 originated at distances greater than 5000 km.

THE report on rainfall registration in Mysore for the year 1910, which has recently reached us, shows that the number of official stations was then 227, in addition to which a few coffee-planters maintain private stations on their estates. Compared with the district averages for the forty years, 1870–1909, the rainfall was in excess by about 8 inches, or 22 per cent. Some heavy falls in twenty-four hours were recorded in each of the eight districts into which the province is divided, the heaviest being 10·8 inches at Nagar and 10·5 inches at Aralagode in the Shimoga district early in July.

THE first report of the Meteorological Observatory in connection with the College of Nuestra Señora de Montserrat, Cienfuegos, Cuba, has just been issued. The volume has been prepared by the Rev. Simon Sarasola, S.J., director, and contains details of the establishment of the observatory, together with notes upon the meteorological observations taken at the college from 1886, and upon cyclones and their prognostication. The position of the observatory is an important one, especially with regard to the Panama Canal, and the results obtained will probably prove of great interest. The instrumental equipment is excellent, including nine self-recording instruments. The tables for 1911, printed in the report, include observations made every two hours, from 6 a.m. to 8 p.m., of barometer, temperature, vapour tension, relative humidity, and direction and force of wind, with cloud observations four times daily and notes on the weather. The tables are not arranged on the international system, although the international symbols are used in the weather columns. It is a matter for regret that the daily maxima and minima of temperature are not printed instead of the highest and lowest of the bi-hourly readings. The absolute extremes of temperature of each month are, however, given in one of the yearly tables.

THE Meteorological Office has commenced the issue of a series of geophysical memoirs, the first of which is by Commander Hepworth, and deals with the effect of the Labrador current on the surface temperature of the North Atlantic, and of the latter on the air temperature and pressure over the British Isles. The author shows from the records of the last eight years that abnormally low temperatures in the North Atlantic are due to the current of cold water from the coast of Labrador and not to the ice which that current brings with it. The low temperature of the water lowers the temperature of the air over these islands by cooling the winds from seawards, by influencing the paths of depressions, and by diminishing cloudiness. When the north-eastern arm of the

North Atlantic is colder than usual, the centres of depressions pass almost directly over the British Isles and produce excessive cloudiness and rain.

The Builder for August 30 has an illustrated article on the reconstruction of the campanile of St. Mark's, in Venice. Preserving the old foundations as a nucleus, a strong enclosure of Istrian stone has been constructed around them; the old foundations had a superficies of 222 square metres, and the present foundations cover 407 square metres, nearly double the surface. As the tower began to rise, a movable framework was employed; for the carrying up of the materials a Steigler elevator was used, which also lifted the bells into position. The bells weigh respectively 3625, 2556, 1087, 1366, and 1011 kilograms, and the angel 1300 kilograms. The tower itself from outside the ground to its summit weighs 8,900,000, and with its foundation included about 12,970,000 kilograms. The Loggetta of Sansovino has also been successfully restored. The loggia had been completely crushed by the campanile in its fall. All the fragments of sculpture were carefully collected before commencing the work of reconstruction; in the group of the Virgin and Child alone there were no fewer than 1600 separate pieces. The new campanile was opened on April 25 of this year.

"THEORIES OF SOLUTIONS," by Svante Arrhenius, director of the Nobel Institute of the Royal Swedish Academy of Science, Stockholm, is being published this week by Mr. Frowde for the Yale University Press. The volume constitutes the eighth of the series of Silliman Memorial Lectures at Yale.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A COMET.—A telegram from the Kiel Centralstelle announces the discovery of a comet by Mr. Gale, of New South Wales, on September 9. The position at 7h. 24·8m. (Sydney M.T.) on that date was:—R.A. = 13h. 37m. 1s., decl. = 36° 31′ 2″ South.

THE MARKINGS OF JUPITER.—A valuable summary of the phenomena attending the various prominent markings on Jupiter is contributed by Mr. Denning to No. 452 of *The Observatory*. He first deals with the large dusky marking discovered by Major Molesworth, in the same latitude as the red spot, in February, 1901. This remarkable object, which can be seen well with a 3-in. refractor, has exhibited some extraordinary variations in length, having, for example, decreased from 115° in June, 1911, to 63° recently. It has also exerted a marked influence on the red spot, the motion of the latter being considerably accelerated at the conjunctions of the two features in 1902, 1904, 1906, 1908, and 1910. For the period 1894–1910 the rate of rotation of the red spot was 9h. 55m. 40·63s., exactly that adopted for system ii., but then a rapid acceleration set in, and for the two succeeding years the period was 9h. 55m. 37·5s. This drifting westward was at the rate of about 22,000 miles per year, but recent observations indicate that it is temporarily suspended.

OBSERVATIONS OF NOVA GEMINORUM NO. 2.—A number of observations of Nova Geminorum No. 2 are discussed in No. 4598 of the *Astronomische Nachrichten*, chiefly dealing with determinations of position and magnitude. Dr. H. E. Lau, from observations made between March 14 and May 18, finds secondary maxima on the light-curve on March 14, 23, and 31, April 18, and May 1. At first the period appeared to be about eight days and the amplitude 1·0 magnitude, but later the period lengthened and the amplitude decidedly decreased. Most of the observations indicate that the magnitude became fairly stationary about the end of May, its value being about 8·0, but Prof. Eginitis records an apparent augmentation from 8·0 on June 4 to 7·4 on June 7.

Prof. Newall states that spectroscopic observations by Messrs. Stratton and Brunt on August 13 showed the nebula line, 501$\mu\mu$, to be much the strongest line in the visible spectrum; other lines observed were at $\lambda\lambda$464 (?), 486 (Hβ), 496, 531 (?), and 575. The magnitude, difficult to estimate, was probably a little brighter than 9·0.

Prof. Strömgren records the magnitude as 7·70, on the PD system, on August 24, while, in No. 452 of *The Observatory*, Mr. Harold Thomson gives it as 7·7 on August 20, on the scale employed by the Variable Star Section of the B.A.A.

THE ORBIT OF ξ PERSEI.—The star ξ Persei is one of those interesting binaries in which the radial velocity as determined from the H and K lines of calcium differs from that determined from the other lines. Its spectrum is of the Oe 5 B class, according to Miss Cannon, and shows lines of H, He, Ca, and Fe, but the H and He lines are generally too diffuse to give trustworthy results for the velocity.

Using the H and K lines only, Mr. Cannon, of the Ottawa Observatory, has derived an orbit from his own measures and those made at the Yerkes Observatory, which he publishes in No. 3, vol. vi., of the Journal of the R.A.S., Canada. He finds the period to be 6·951 days, the range of velocity 15·7 km., and the velocity of the system 15·4 km. The diameter of the projected semi-major axis of the orbit is 751,800 km. An attempt was also made to determine the velocity from the broad lines, other than calcium, but nothing more definite can be said than that they show a much higher positive velocity than do the H and K lines.

CATALOGUE OF STELLAR PARALLAXES.—No. 24 of the Publications of the Astronomical Laboratory at Groningen contains a wealth of information concerning the parallaxes, probable intrinsic luminosities, &c., of 365 stars. The table has been made up from many sources, and relative weights are given to the different values. There are eleven stars with parallaxes greater than +0·300″, the five nearest, with their adopted parallaxes, being: α Centauri (+0·759″), Sirius (+0·376″), Piazzi, oh. 130 (+0·360″), τ Ceti (+0·334″), and Procyon (+0·324″). Ten stars have computed luminosities greater than one hundred times that of the sun, the five most luminous being: β Centauri (520), Regulus (423), Achernar (350), Capella (300), and Arcturus (230); the values in brackets are the computed luminosities, that of the sun being taken as unity.

THE ORBITS OF COMETS.—In No. 4598 of the *Astronomische Nachrichten*, Prof. Strömgren points out, in reference to a recent note by Prof. W. Pickering on the fundamental form of cometary orbits, that Prof. Pickering has misconstrued the sense of his conclusions. The final contention of Prof. Strömgren's (not Prof. Kobold's, as was inadvertently stated in our previous note on August 15) was that if the effects of Newtonian gravitation be strictly taken into consideration it is probable that all the cometary orbits yet considered would prove to be *elliptical*.

AMERICAN MINERAL STATISTICS.[1]

THE annual report of the production of minerals in the United States has been issued for 1910 by the United States Geological Survey in the form of two bulky volumes dealing with metallic and non-metallic products respectively. Most of the statistical information had been already published in the special pamphlets issued from time to time by the Geological Survey, so that the present volumes contain no new facts, although they add a great quantity of important and interesting details, whilst the study of the subject is, of course, greatly facilitated by the collection and juxtaposition of all the various items.

The total value of the mineral production is given as a little more than 2,000,000,000 dollars, an increase of 6·2 per cent. over that of 1909. This figure is quite comparable with the values of output of the United States for previous years, but is not comparable with those for other countries, because of a number of inexactitudes due to the method in which the returns are presented. As has more than once been pointed out, the grand total contains a number of reduplications, in spite of the statement in the report itself that "all unnecessary duplication has been excluded." The report directs attention to the fact that the value of the coke produced, practically 100,000,000 dollars, is excluded from the total, because "the quantity and value of the coal used in its manufacture are included in the statistics of coal production." It neglects the equally important fact that practically the whole of this coke is consumed in the production of metals, such as pig-iron, copper, and lead, and as the value of these metals is given, and not merely that of the ores from which they are extracted, the cost of the coke is really included in the value assigned to the metals. If the total value assigned to mineral products is to be correct, the value of all the fuel used for metallurgical purposes, and for burning clay products, lime, cement, &c., should be deducted from the grand total; this is by no means a trifling correction, for it would probably mean a diminution of the total by something like 10 per cent.

Care has been taken in this report to include only metals produced from domestic ores as far as possible; this brings out the very interesting fact that the recovery of metals from residues, by-products, waste materials, &c., is assuming very important dimensions. Thus in 1910 the production of zinc, here called "primary spelter," direct from domestic ores amounted to 252,479 tons, and that of zinc from imported—chiefly Mexican—ores to 16,705 tons, whilst the quantity of so-called "secondary zinc" recovered from waste and scrap materials of various kinds was no less than 68,723 tons, or about a quarter of the production of primary spelter. In the case of tin the figures are still more striking; the quantity of tin obtainable direct from ores is not stated, but appears to be of the order of some 40 tons, whilst the recovery of secondary tin from scrap of all kinds amounted to no less than 13,903 tons. It is calculated that the recovery of secondary tin throughout the world is only 27,000 tons, so that one-half of this production takes place in the United States. Seeing that the world's output of primary tin was about 115,920 tons in 1910, the recovery of tin from scrap is assuming very important dimensions.

Amongst the non-metallic minerals, coal is, of course, by far the most important, the output for 1910 exceeding 500 millions of tons, this being the first time that this figure has been attained. The mineral output shows steady and progressive development in practically all directions, and these volumes afford conclusive evidence of the prominent position that the mineral riches of the United States hold amongst the sources of national wealth. It should, however, in all fairness be added that these two fine volumes of mineral statistics are not unworthy of the flourishing industries, the progress of which they chronicle. Is it too much to hope that we may have some day in this country a record of mineral statistics that might worthily sustain comparison for accuracy and completeness with that issued by the United States Geological Survey?

H. L.

[1] "Mineral Resources of the United States, Calendar Year, 1910." Part i., Metals. Pp. 796+plate. Part ii., Non-metals. Pp. 1005+plates. Washington: Government Printing Office, 1911.)

INCOME OF AMERICAN COLLEGES OF UNIVERSITY RANK.

THE second volume of the report of the United States Commissioner of Education for the year ended June 30, 1911, has now been received from Washington. It is chiefly devoted to statistical details concerning the development and present provision of educational facilities in institutions of all the grades included in the American system of education. Especially interesting are the facts which may be gathered respecting education of university rank.

The total receipts of the universities in the United States are given as 18,934,410*l.*, derived from a variety of sources, as shown in the following table:—

Total Receipts of Universities and Colleges for the year ended June 30, 1911.

	£
Tuition and other educational fees ...	3,698,600
Room rent	381,700
Board and other non-educational fees ...	1,218,970
Productive funds	2,658,700
State or city for increase of plant	932,430
,, ,, current expenses	2,941,450
United States Government	1,175,040
Private benefactions for increase of plant ..	1,144,700
,, ,, endowment ...	2,753,970
,, ,, current expenses ...	693,950
All other sources	1,334,900
Total receipts	18,934,410

More detailed information is provided as to the benefactions given during the year under review, which exceeded four and a half millions sterling, or 4,592,620*l.* to be precise. We notice, for example, that the total is more by 845,200*l.* than was received during 1909–1910. Fifty universities and colleges each received gifts amounting to more than 20,000*l.*, and, as the following table shows, seven universities and colleges were fortunate enough to benefit to the extent of 100,000*l.* or more.

Universities and Colleges receiving 100,000l. or more in Benefactions during 1910–11.

	£
Columbia University	507,010
Harvard College, Massachusetts	349,090
University of Chicago	271,790
Yale University	226,880
New York University	185,690
Dartmouth College, New Hampshire ...	156,890
Amherst College, Massachusetts	101,950

A separate chapter in the report deals with agricultural and mechanical colleges, but the Commissioner is careful to point out that some of them are also included under universities and colleges, so that overlapping occurs. The following table shows the total income of the agricultural and mechanical colleges for the year under consideration. Grants for experiment stations, farmers' institutes, and other means for extending agricultural education are not included in the amounts shown.

Income of Agricultural and Mechanical Colleges for 1910–11.

	£
Income from State endowment	22,890
Appropriations for current expenses ...	1,004,990
Tax levy ,, ,, ...	575,820
Appropriations for increase of plant ...	558,410
Tax levy ,, ,, ...	100,440
Total State aid ...	2,262,550
From land grant of 1862	156,670
From other land grants	47,090
Additional endowment	450,000
Total Federal aid ..	653,760
From other endowment funds	149,800
Tuition and incidental fees	487,310
Other sources	562,500
Total income ...	4,115,920

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. G. MCKERRON has, with the approval of the King, been appointed professor of midwifery in the University of Aberdeen, in succession to Prof. W. Stephenson, who has resigned.

THE foundation stone of a new college for the training of teachers at Dundee was laid on Thursday last by Lord Camperdown. The cost of the building will be 60,000*l.*, and provision will be made for 400 students.

PROF. J. LORRAIN SMITH, F.R.S. (at present professor of pathology and pathological anatomy in the University of Manchester) has been appointed to the chair of pathology in the University of Edinburgh, in succession to Prof. W. S. Greenfield, who is retiring from the position.

THE sum of 5000*l.* has been given by the Lord Lieutenant of Berkshire, Mr. J. H. Benyon, towards the new buildings of University College, Reading. The donor has apportioned his gift between the new hall, the Letters Buildings, the Agricultural Buildings, and the new St. Patrick's Hall.

THE Board of Agriculture has issued a scheme under which the University College of North Wales, Bangor, will undertake advisory work in forestry for the whole of Wales. Prof. F. Story, professor of forestry at the College, has been appointed to the position of advisory officer for all Wales under this scheme. Prof. Story will retain his professorship, but Mr. Thomson Thomson has been appointed assistant lecturer under him.

THE Senate of the projected University of Western Australia recently advertised eight professorships, and the Agent-General for the State reports that the response has been of a character justifying the belief of good appointments being made. The Senate now invites applications for lectureships in veterinary science and mental and moral philosophy. It is stated that Crawley Park, near Perth, which contains spacious grounds, is likely to be selected as the site of the new institution.

THE fourth international congress of physical education is to be held in Rome on October 24 to 27. Discussions are to take place on the organisation of physical education as a preparation for military service; a rational method of physical training in primary, middle, and secondary schools; the value of sports in physical education, and their physiological limitations; the physical education of woman in relation with her function in the family and in society; respiratory gymnastics and choral singing in schools; open-air schools; the physical exercises suitable for the prophylaxis of tuberculosis.

THE following are the arrangements for the opening of the winter session of certain of the medical schools:—That of St. Bartholomew's Hospital will be inaugurated on October 1 by an old students' dinner; at Charing Cross Hospital the prizes will be distributed on October 2 by the Bishop of Peterborough and Lady Mary Glyn; at St. George's Hospital the prizes will be distributed on October 1, and an address delivered by Mr. H. B. Grimsdale on "The present Duty of the Medical Citizen"; at Guy's Hospital there will be a conversazione on October 4 by the Pupils' Physical Society, the session commencing on October 1; at the London Hospital the Schorstein memorial lecture will be delivered on October 1 by Prof. T. W. Griffith; at the London School of Medicine for Women an address on "Common Sense" will be given on October 1 by Dr. Jane Walker; King's College Hospital will hold a dinner on October 1; at the Middlesex Hospital the prizes will be distributed on October 1 by Sir Charles Wyndham, and an address delivered by Dr. W. S. Lazarus-Barlow on "The Genius of the Infinitely Little"; at St. Mary's Hospital on October 1 the Lord Mayor of London will deliver an address and distribute the prizes; in connection with St. Thomas's Hospital there will be an old students' dinner on October 1; the Westminster Hospital School will have a dinner on October 3; a dinner, on October 2, will inaugurate the new session of the University College Hospital School; there will be a conversazione on October 1 in connection with the University of Birmingham; an address will be given on October 1 at the University of Manchester by Dr. H. D. Rolleston on "Universities and Medical Education," and at the University of Leeds an address will be delivered on October 1 by Sir Alfred Keogh, K.C.B.

THE new session of the Sir John Cass Technical Institute, Aldgate, E.C., which is especially devoted to technical training in experimental science and in the artistic crafts, will commence on Monday, September 23. The instruction in experimental science provides systematic courses in mathematics, physics, and chemistry for London University examinations, in addition to the courses on higher technological instruction, which form a special feature of the work of the institute. In connection with the latter, several new departures are being made for the coming session. The curriculum of the fermentation industries has been much developed, and now includes courses of instruction on brewing and malting, on bottling and cellar management, and power and mechanical plant in the brewery, on the microbiology of the fermentation industries, and on the chemistry and technology of hops, in addition to courses in chemistry and physics for those who have not sufficient previous knowledge of these subjects. In the department of physics and mathematics a special course of lectures and demonstrations will be given on colloids, which will deal with the methods employed in their investigation and their relation to technical problems; also a special course of lectures on the theory and application of mathematical statistics, in which the application of modern mathematical methods of dealing with statistical data in social, educational, economic, and physical problems will be discussed and opportunity given to students to investigate problems on their own account. In the metallurgy department, in addition to the ordinary courses of instruction in general metallurgy, several special courses of an advanced character are provided. The special courses on liquid, gaseous and solid fuel have also been extended, and in addition to a course of lectures, will include laboratory work on fuel analysis, and on technical gas analysis. It is also of interest to note that included amongst the language classes is a course on scientific and technical German.

A long resolution embodying the oft-repeated education demands of the Trade Union Congress was adopted unanimously at a meeting of the congress at Newport (Mon.) on September 4. The main points are as follows:—(1) A national system of education under full public control, free from the primary school to the university; (2) The adequate maintenance of school children; (3) Scientific physical education with annual individual medical inspection, and records showing the physical development of each child; (4) that secondary and technical education be an essential part of every child's education, and secured by such a reform and extension of the scholarship system as will place a maintenance scholarship within the reach of every child, and thus make it possible for all children to be full-time day pupils up to the age of sixteen; (5) That the best intellectual and technical training be provided for the teachers of the children, that each educational district shall be required to train the number of pupil teachers demanded by local needs, and to establish training colleges, preferably in connection with universities or university colleges; (6) that the provision of educational buildings and facilities be obligatory upon the local authority, which shall always retain administrative control of the buildings and facilities so provided; (7) that the cost of education be met by grants from the Imperial Exchequer, and by the restoration of misappropriated educational endowments. The congress placed on record its emphatic disapproval of the refusal of Ministers of Education to grant the demand for a Royal Commission to inquire into such endowments; and instructed the Parliamentary Committee once more to press for the appointment of such a Royal Commission, which shall inquire into: (*a*) The finances of the universities and of the great public schools; and to issue a report containing a statement of the history and present value of those endowments which were originally intended for the poor; (*b*) the conditions of scholarships and other aids in universities and public schools; (*c*) the relations with lower education institutions; (*d*) the government of universities and public schools, and to bring forward recommendations showing how these institutions may be brought under full public control.

Secondary education in New South Wales has now been organised completely, and Mr. Board, the director of education, in announcing at the beginning of July last a series of appointments to the high schools, described the character of the system which has now been inaugurated. We learn from *The Sydney Morning Herald*, that Mr. Board claims for the New South Wales scheme of secondary education that it assigns a definite time for the studies of a secondary school, making four years the minimum which any student should spend on these studies. Another good point is the certificating system, which connects the secondary school with the primary school on one hand and the university on the other, and also leads definitely to certain well-marked types of career —for example, the technical or the commercial. Attached to the scheme of certificates is the system of examination. The examinations are, in the first place, school examinations as well as tests of individual attainments. In the second place, the results of the examination will be modified by consideration of the school record of the pupil, and, again, the examination can only follow upon the completion of a specific programme of studies that has occupied a definite period of time, and in the last place the examinations for the certificates are closely associated with the thorough inspection of the schools. A specially constituted board of examiners, representing both the University and the Education Department, will determine the award of all certificates. In a few years there will be a large number of efficient high schools under the control of the Department of Public Instruction, and it is hoped that a leaving and intermediate examination will be carried on somewhat on the lines of that in Scotland. The alternative scheme, which was not adopted, was a system of inspection and examination by the University of Sydney. That is not, however, the true function of a university. Sydney has acted wisely in not undertaking it, though the University may assist, as it has done, to strengthen the State Education Department, and get it to organise secondary education as well as primary and technical.

SOCIETIES AND ACADEMIES.

Calcutta.

Asiatic Society of Bengal, August 7.—R. K. **Bhide**: Two more new species of Gramineæ from Bombay. Two new species of grasses are described, (1) *Chloris quinquesetica*, collected by Mr. G. A. Gammie, and subsequently by the author, from Bassein, and (2) *Sporobolus scabrifolius*, collected by the author from Rannebennur.—Manindra Nath **Banerjee**: A measure of chemical affinity. The chemical activity of an element bears a simple relation to its density; if its atomic volume be divided by its density, the figure obtained, for which the name "specific extensity" is suggested, gives a measure of the chemical activity of the element. For instance, platinum, which is a very inactive element, is near one end of the scale with a specific extensity of 0·42; hydrogen, a very active one, is near the other end with a specific extensity of 127·25. There are a number of exceptions to the rule, the most obvious being the inactive gases found in the atmosphere.—Rev. H. **Hosten**: The mouthless Indians of Megasthenes. According to Megasthenes, there lived near the sources of the Ganges a tribe of people, the Astomoi, who had no mouth, but merely orifices through which they breathed. They ate and drank nothing. When they went on a distant journey, they took with them certain roots and flowers or wild apples, on the perfumes of which they subsisted. "Should they inhale very foul air death is inevitable." The tribe is found mentioned in conjunction with the Trispithami (men of three spans long), the Pygmies, and the Scyritæ or Scyratæ (Kirātas), tribes whose characteristic features are distinctly Mongolian or Himālayan. A number of texts are quoted to prove that the "foul air" against which the Astomoi had to protect themselves represents the phenomenon known as *mal-de-montagne*, or breath-seizure, and that the "wild apples" they used as antidote were onions, dried apples, and apricots, nostrums employed in the Himālayas wherever breath-seizure prevails. The fact that some hill tribes used in their travels fruits of which they inhaled the perfume, lest the "foul air" should kill them, seems then to have led to the idea that they subsisted on nothing else. From this to the belief that they needed no mouth, and, in fact, had none, or "instead of mouths had orifices through which they breathed," the inference was easy.—Rev. Fr. Nicholas Krick: Account of an expedition among the Abors in 1853. The recent expedition among the Abors gives renewed interest to Fr. Krick's visit to them in 1853. His "Relation d'un voyage au Thibet en 1852 et d'un voyage chez les Abors en 1853" (Paris, 1854) has become scarce; hence we are under obligations to Rev. Fr. A. Gille, S.J., for having translated that part which concerns the Abors. Fr. Krick's remarks on their manners and customs are as applicable to-day as they were nearly sixty years ago.

BOOKS RECEIVED.

Catalogue Général des Antiquités Egyptiennes du Musée du Caire. Nos. 61051–61100: The Royal Mummies. By Prof. G. Elliot Smith. Pp. vii+118+103 plates. (Le Caire: Imprimerie de l'Institut Français.)

Eine physiologische Histologie des Menschen- und Saügetier-Körpers im Wort-Bild und Präparat. By Prof. F. Sigmund. Lief. i., Die Haut. Zweite verbesserte Auflage. Pp. 38. (Stuttgart.) 9.50 marks.

Kreislaufvorgänge in der Erdgeschichte. By Prof. G. Linck. Pp. iii+40. (Jena: G. Fischer.) 1.50 marks.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. ii., part 5. (Sydney: W. A. Gullick.) 2*s.* 6*d.*

Elementary Entomology. By E. D. Sanderson and Prof. C. F. Jackson. Pp. vii+372. (London: Ginn and Co.) 8*s.* 6*d.*

A Text-Book of Botany. By Profs. E. Strasburger, H. Schenck, L. Jost, and G. Karsten. Fourth English Edition, revised with the tenth German edition, by Dr. W. H. Lang. Pp. xi+767. (London: Macmillan and Co., Ltd.) 18*s.* net.

A Text-book of Pathology. By Drs. J. G. Adami and J. McCrae. Pp. x+759. (London: Macmillan and Co., Ltd.) 25*s.* net.

A Hand-list of the Lichens of Great Britain, Ireland, and the Channel Islands. By A. R. Horwood. Pp. 45. (London: Dulau and Co., Ltd.) 1*s.* net.

The People's Books:—Practical Astronomy with the Unaided Eye. By H. Macpherson, jun. Pp. 94. Theosophy. By Annie Besant. Pp. 94. Rudolf Eucken: a Philosophy of Life. By Dr. A. J. Jones. Pp. 94. Dietetics. By Dr. A. Bryce. Pp. 94. Aristotle. By Dr. A. E. Taylor. Pp. 91. Aviation: its Principles, its Present and Future. By S. F. Walker. Pp. 96. The Evolution of Living Organisms. By E. S. Goodrich. Pp. 108. Embryology: the Beginnings of Life. By Dr. G. Leighton. Pp. 92. (London and Edinburgh: T. C. and E. C. Jack.) 6*d.* net each.

Dactylography, or the Study of Finger-prints. By H. Faulds. Pp. 127. (Halifax: Milner and Co.) 1*s.* net.

Fortschritte der naturwissenschaftlichen Forschung. By Prof. E. Abderhalden. Sechster Band. Pp. iii+300. (Berlin and Vienna: Urban and Schwarzenberg.) 1 mark.

The People's Medical Guide. By Dr. J. Grimshaw. Pp. xx+839. (London: J. and A. Churchill.) 8*s.* 6*d.* net.

Analytical Geometry. By C. O. Tuckey and W. A. Nayler. Pp. xiv+367. (Cambridge University Press.) 5*s.* net.

Examples in Applied Electricity. By C. G. Lamb. Pp. iv+61. (Cambridge University Press.) 2*s.* 6*d.* net.

The Building of the Alps. By Prof. T. G. Bonney. Pp. 384. (London: T. F. Unwin.) 12*s.* 6*d.* net.

Das Gesetz der Wüstenbildung in Gegenwart und Vorzeit. By Prof. J. Walther. Zweite Auflage. Pp. xv+342. (Leipzig: Quelle and Meyer.) 12 marks.

Chemical Theory and Calculations. By Drs. F. J. Wilson and I. M. Heilbron. Pp. iv+138. (London: Constable and Co., Ltd.) 2*s.* 6*d.* net.

The Lushei Kuki Clans. By Lieut.-Col. J. Shakespear. Pp. xxii+250. (London: Macmillan and Co., Ltd.) 10*s.* net.

From the Black Mountain to Waziristan. Being an account of the Border Countries and the more turbulent of the Tribes controlled by the North-west Frontier Province, and our Military Relations with them in the East. By Col. H. C. Wylly. Pp. xx+505+8 maps. (London: Macmillan and Co., Ltd.) 10*s.* 6*d.* net.

A Preparatory Arithmetic. By C. Pendlebury. Pp. xiv+185+xxx. (London: G. Bell and Sons, Ltd.) 1*s.* 6*d.*

Man's Place in the Universe. By Dr. A. R. Wallace, O.M. New and cheaper edition. Pp. vi+283. (London: Chapman and Hall, Ltd.) 1*s.* net.

Nature Photography. By S. C. Johnson. Pp. 115. (London: Hazell, Watson and Viney, Ltd.) 1*s.* net.

Contributions from the Jefferson Physical Laboratory of Harvard University for the Year 1911. Vol. ix. (Cambridge, Mass., U.S.A.)

Palæolithic Man and Terramara Settlements in Europe. By Dr. R. Munro. Pp. xxiii+507+75 plates. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson.) 16*s.* net.

CONTENTS.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

No. 2238, VOL. 90] THURSDAY, SEPTEMBER 19, 1912 [PRICE SIXPENCE

Registered as a Newspaper at the General Post Office.]

THURSDAY, SEPTEMBER 19, 1912.

CHEMICAL TECHNOLOGY.

(1) *Bleaching and Dyeing of Vegetable Fibrous Materials.* By Julius Hübner. With an Introduction by Prof. R. Meldola, F.R.S. Pp. xxiii+434. (London: Constable and Co., Ltd., 1912.) Price 14*s.* net.

(2) *German Varnish-making.* By Prof. Max Bottler. Authorised Translation with Notes on American Varnish and Paint Manufacture. By A. H. Sabin. Pp. vii+363. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.) Price 15*s.* net.

(3) *Allen's Commercial Organic Analysis.* Edited by W. A. Davis and S. S. Sadtler. Fourth edition. Entirely re-written. Vol. vi. Pp. ix+726. (London: J. and A. Churchill, 1912.) Price 21*s.* net.

(1) THIS is a practical manual intended for the use of students and junior employees. The purely scientific aspect of bleaching and dyeing is not within the scope of the work. As Prof. Meldola remarks in an interesting introduction, Mr. Hübner knows the theoretical side of the industry as well as anybody does . . . but his present treatment of his subject is not intended to supersede but to superadd to the scientific treatment. About one-third of the book is devoted to the description of bleaching operations, including some preliminary sections dealing with the materials employed, namely, the textile fibres, water, chemicals, and mordants. After a few pages on mercerising, the rest of the space is allotted to the discussion of dyestuffs and dyeing procedure. Practical directions for carrying out the operations are given, and frequently different methods of applying the same dyestuffs are adduced for purposes of comparison. There are numerous illustrations, chiefly of sections of machinery; and a feature of these is that in many cases they are made much more intelligible than usual by the use of a two-colour device to show the course of the fabric through the machine. The book can be cordially recommended as a concise and up-to-date compilation of practical information.

(2) Mr. Sabin is an enthusiast on the subject of paints and varnishes, and his translation of Prof. Bottler's book is far from being dry reading. The original is too concise and brief, in the translator's opinion; he has therefore added a number of notes *en passant.* These are printed distinct from the main text, and include useful bibliographical references, explanatory comments, and extensions of matters mentioned in the original or suggested by it. For example, when resenes are first referred to (as constituents of copal and other resins), Mr. Sabin interpolates a brief account of their properties, with a reference and a criticism. Hence the work may be looked upon as giving the German practice in varnish-making, annotated from the American point of view. But in addition to the running notes, Mr. Sabin contributes whole chapters also; one upon miscellaneous points in the manufacture of varnish, and one on the nature and constitution of paint; there is, further, a useful appendix of notes and references on analytical methods employed in the examination of varnishes. It is worthy of remark that, according to the translator, "our (*i.e.*, the American) methods are based upon English practice, and the English alone among foreign nations are still able to sell varnish here against our best makers."

(3) The general characteristics of the new edition of Allen's "Commercial Organic Analysis" are now tolerably familiar to users of the work, and in this connection it need only be noted that the sixth volume follows much the same lines as its predecessors. It is concerned with the chief organic bases and the alkaloids. All the latter, however, are not dealt with, some being relegated to the succeeding volume. The amines, anilines, naphthylamines, and their allies are discussed by Messrs. Davis, Sadtler, and Glover respectively. In dealing with the alkaloids, the plan has been to have first a general description of the vegetable alkaloids (this is contributed by Dr. Henry), and then to have the various groups of these products dealt with by special contributors.

It is perhaps invidious to single out any sections where all appear to be well done, but mention may be made of the articles on the volatile alkaloids and the opium group by Mr. F. O. Taylor; those on the aconite alkaloids and on atropine and its allies by Mr. F. H. Carr; and that on the cinchona group by Mr. Oliver Chick. The section on caffeine, tea, and coffee, by Messrs. Fox and Sageman, is a very useful contribution, as is also that on cocoa and chocolate by Mr. Whymper; the former is illustrated with photographs of leaves said to have been used as adulterants of tea, and by some diagrammatic sketches showing the microscopic structure of tea, coffee, and chicory.

The descriptions of the theoretical chemistry of the various products dealt with in the book appear to be trustworthy, and it is a convenience to have them in conjunction with the analytical working details. A little more careful proof-reading would have detected a number of misprints.

THE GOLDEN BOUGH.

The Golden Bough: A Study in Magic and Religion. By Prof. J. G. Frazer, D.C.L. Third edition. Part v.: "Spirits of the Corn and of the Wild." In 2 vols. Vol. i., pp. xvii + 319. Vol. ii., pp. xii + 371. (London: Macmillan and Co., Ltd., 1912.) Price, 2 vols., 20*s.* net.

AT the conclusion of his elaborate study of "Spirits of the Corn," Prof. Frazer observes that "while the fine flower of the religious consciousness in myth, ritual, and art is fleeting and evanescent, its simpler forms are comparatively stable and permanent, being rooted deep in those principles of common minds which bid fair to outlive all the splendid but transient creations of genius. It may be that . . . simple folk will still cherish the simple faiths of their nameless and dateless forefathers. . . ." In his feeling for the system he has studied so long and so minutely, the Darwin of religion resembles Ernest Renan, who came to regard affectionately the Christian and Pauline subjects of his analysis.

But a more interesting point is the suggestion that superstition "springs eternal in the human breast." If there is anything in the suggestion, it is that what we know as superstitious tendencies, crystallising into religious forms, are part of the mechanical workings of the human brain. For undoubtedly these multiple variations of a few simple ideas persist, just as they first developed, in subconscious or unconscious thought. It is only the primitive explanations of belief and ritual that show conscious exercise of the brain. From a similar point of view, Adolf Bastian has remarked the deplorable sameness and the small number of the conceptions of the human mind.

Such views and such prognostications seem to forget that mental action is relative to its object, that it varies in form as its knowledge of the object, and, consequently, that science can alter, and has altered, the "principles of common minds." And, after all, this rich crop of myth, ritual, and religion, so carefully harvested in "The Golden Bough," is but the chaff of man's imagination, however persuaded he may be that it is golden grain. For the true seeds of the mind are scientific; during countless ages they were garnered in absolute unconsciousness, fancy playing meanwhile with the flying chaff.

The mistake of regarding these recurrent and multitudinous expressions of man's mental "play" as the foundation of his individual and social achievements will not be made by the synthetic sociologist of the future. He will take the logical mechanism of the mind in its relation with increasing knowledge as the foundation, and relegate the iridescent play of religion and superstition to the sphere of the imagination, as a part of æsthetics. But this "play," simultaneous with, or preceding, or following, mental adaptation to reality will be of value in determining the nature and quality of that adaptation. And the social psychologist needs no further material than that supplied in "The Golden Bough" and in "Totemism and Exogamy" for understanding the tendencies of the mind when free from scientific relations.

The discussion of "Spirits of the Corn and of the Wild" is the main stem of "The Golden Bough." Mannhardt's studies, which inspired it originally, have found a multiplex reincarnation. Besides the general extension of material there are interesting and valuable episodes, such as the connection of the Pleiades with agriculture, woman's part in agriculture, games in agriculture. A delightful essay on Empedocles as a pioneer of evolution and in comparison with Herbert Spencer shows the author's style at its best.

A. E. Crawley.

SOME PHYSIOLOGICAL MONOGRAPHS.

(1) *Schutzfermente des tierischen Organismus.* By Emil Abderhalden. Pp. xii + 110. (Berlin: Julius Springer, 1912.) Price 3.20 marks.

(2) *Les Parathyroïdes.* By L. Morel. Pp. iii + 344. (Paris: A. Hermann et Fils, 1912.) Price 10 francs. (Questions Biologiques Actuelles.)

(3) *Le Goût et l'Odorat.* By J. Larguier des Bancels. Pp. x + 94. Paris: A. Hermann et Fils, 1912.) Price 3.50 francs. (Questions Biologiques Actuelles.)

(4) *The Physiology of Protein Metabolism.* By Dr. E. P. Cathcart. Pp. viii + 142. (London: Longmans, Green and Co., 1912.) Price 4*s.* 6*d.* net. (Monographs on Biochemistry.)

(1) PROF. EMIL ABDERHALDEN is probably about the busiest physiological investigator at the present day; he is certainly the most prolific writer. Not only do original papers flow in a steady stream from his laboratory, but he has also the time and energy to edit and write books. The work mentioned above is one of the most recent of these, and in it he collates the results of his own work and that of others on one of the most interesting developments of recent biochemical study. It deals with the protective mechanisms of the body, and especially with the part played by enzymes in resisting the effects of introducing foreign material into it. This is only part of the large subject included under the general heading of Immunity, but it is an important part. It is, for instance, well known that if "peptone"

is introduced into the blood-stream a very serious train of symptoms results which may terminate fatally. Healthy blood contains no enzymes capable of splitting peptone into its simpler and more harmless constituents. But by educating an animal by gradually introducing successively increasing doses of the poison, the blood acquires the property of dealing with it, owing to the genesis of peptolytic enzymes. This is only one example of the sort of thing which is continually occurring; many others are given, which the reader must discover for himself. The little book is valuable also because it deals clearly with the methods, especially the so-called "optical method," which have been elaborated by the author for the detection of the enzymes in question.

(2) The parathyroid glands were only discovered in 1880, and their importance in the life of the organism was not recognised until some years later. Removal of the thyroid body produces results analogous to those which occur when this organ is the seat of disease. Now that its neighbours, the parathyroids, have been recognised, much controversy has centred around the question as to how much of the effect is due to removal or disease of the latter bodies rather than of the thyroid itself. Much difference of opinion still prevails, but it is pretty generally admitted that what is known as tetany is a symptom rather of parathyroid than thyroid insufficiency. The main facts and views are set out with admirable lucidity in the second book mentioned above, and Dr. Louis Morel, the author, is to be congratulated, not only on having written such an interesting book, but on having added to it a valuable bibliography of the subject. This extends over nearly twenty closely printed pages in double columns, and seeing the recent date of our knowledge even of the existence of these little organs, we have an illustration of the industry of modern physiological and pathological investigators.

(3) The next monograph on our list is published in the same series, which is being published under the editorship of Prof. Dastre. In it, Dr. des Bancels gives the most up-to-date information regarding the two special senses, taste and smell.

(4) Dr. Cathcart's contribution to the biochemical monographs which Messrs. Longmans are publishing deals with the important subject of protein metabolism. This also is enriched with an excellent bibliography. Although one must admire the way in which the author has placed before his readers all the latest information on the complex problems involved, one is naturally disappointed to find how many of these still continue in an uncertain state. That, however, is not Dr. Cathcart's fault, and we must rejoice that he has himself done so much in the way of research to illuminate the dark places of scientific knowledge. It can only be a question of time and hard work before our difficulties in the interpretation of facts will disappear. W. D. H.

OUR BOOKSHELF.

Die Radiumkrankheit tierischer Keimzellen. Ein Beitrag zur experimentellen Zeugungs- und Vererbungslehre, by O. Hertwig. Pp. iii + 164 + Taf. i–vi. (Bonn: F. Cohen, 1911.) Price 8 marks.

The author has planned and carried out a comprehensive series of experiments with a view to ascertain the effect of exposing to radium the ova and spermatozoa of animals, and of exposing the normal embryo in various stages of its development.

The axolotl and the frog (*Rana fusca*) were used in the experiments. The results show that exposure to radium leads, at every stage, to imperfect development of the embryo; numerous illustrations (in the text and in six special plates) show that inhibition of development and abnormal development are readily produced.

The book is divided into three parts; the first and second parts deal with experiments on amphibian ova and embryos; the third part with those of echinoderms.

The first part describes the results of irradiating fertilised ova at the beginning of segmentation, and the male reproductive cells before fertilisation. The second part describes the changes following exposure of the normal embryo at the several characteristic stages, such as the gastrula stage, the development of the nerve-plate, and of the spinal cord.

A number of microscopical sections are included in the illustrations to show the far-reaching nature of the changes produced by exposure to the rays of radium.

Antropologia Generale. Lezioni sull' Uomo secondo la Teoria dell'Evoluzione. By Prof. Enrico Morselli. 671 figs. + 1 plate + 3 maps. (Turin: Unione Tipografica, Editrice Torinese, 1901–1911.)

From 1887 until 1908 Prof. Morselli, who is by profession a physician, devoting himself to the study and cure of mental diseases, has been in the habit of delivering free courses of lectures on anthropology. The lectures, which have been in the course of publication, by instalments, for a number of years past, have now been completed, and form a work which represents a monument of patient and painstaking industry. In its conception and execution this work resembles the treatises which are so often produced by men attached to German universities.

Prof. Morselli's personality is never obtrusive: he seeks to express the facts as seen and rendered by others; he keeps his own opinions in the background. In the preface he acknowledges his indebtedness to Haeckel. "Antropologia Generale," however, is even wider in its scope than the "Natural History of Creation." The opening lectures are devoted to a historical account of the various hypotheses which have been formulated regarding man's origin and evolution, and to the bearing of Darwin's work on the modern problems of anthropology. The following chapters have even a wider sweep; they deal with life, the conditions of life, as far back in the world's history as human imagination can reach. Embryology, growth, anatomy, and all the various kinds of knowledge which have even a remote bearing on the human body are woven into the subject-matter of Prof. Morselli's lectures.

The chapters dealing with extinct and past forms of men are very complete. One is rather surprised to observe that he accepts in good faith all the discoveries of ancient man which have been made in South America in recent years. The concluding lecture pictures the man of the future as a form of Greek god. The numerous illustrations, although they have often little connection with the part of the text in which they appear, are well executed, and have been selected from many standard works and original papers.

The work is so ambitious in aim and so wide in its scope that it is impossible for any single man to obtain a first-hand knowledge of all its parts; few could have completed so successfully the task which Prof. Morselli imposed on himself.

An Outline of the Russo-Japanese War, 1904, 1905. By Col. Charles Ross, D.S.O. Vol. i., Up to, and including, the Battle of Liao-Yang. Pp. xxv+490+14 maps. (London: Macmillan and Co., Ltd., 1912.) Price 10*s*. 6*d*. net. (Military Text-Books.)

THIS account of the latest of the great campaigns of modern history takes the story up to the close of the first stage of the Japanese advance into Manchuria, which was marked by the complete and final severance of the field army under Kuropatkin from the troops interned in Port Arthur.

Naturally in so comparatively short a work it has been impossible for the author to enter into any discussion of tactical problems or to refer to the doings of the smaller units, whether in action or during the various strategical movements of the campaign. He has succeeded, however, in giving a very clear view of the earlier phases of the war, and of the numerous influences that guided the actions of the opposing commanders.

The chapters dealing with the war itself are exceedingly clearly written, and the contrast between the divided counsels that confused the Russian strategy and the impassive unanimity that ruled the movements of the Japanese is well brought out. As one would expect from an author bearing the name of Ross, not only are the facts clearly stated but the lessons to be learnt from them are philosophically discussed. The book should be read by all who desire to get a clear view of the campaign, unencumbered by technical detail, or to realise the effect on the art of war of modern scentific advances. C. H. M.

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.*]

Practical Mathematics.

IT is surely rather a pity that Prof. Perry concluded his letter with such a violent attack on the "professional mathematician." If he had attached a little less importance to Sir William White's address and a little more importance to the proceedings of, and reports presented to, the Educational Section of the Congress, I think he would find ample justification for withdrawing, or at least qualifying, his statement that the teacher "never studies his pupil," or that "the poor average English boy is never studied by the professional mathematician."

One of the main changes that is taking place at the present time consists in the introduction of the calculus at a much earlier stage in our mathematical curricula than was ever dreamt of fifteen years ago. Surely this and many other equally important changes owe their inception largely to what has often been described as the "Perry movement." After all, only a small percentage of the boys who study mathematics at school intend to qualify for the engineering profession. It is in connection with the education of the large body of pupils who learn mathematics as part of a general education that the introduction of the practical element is producing the most beneficial results. G. H. BRYAN.

Weather and the Ultra-violet Radiations of the Sun.

I WAS rather astonished by Dr. Carl Ramsauer's second letter in NATURE of June 13, which has just reached me, and although "the weather of 1911" is rapidly becoming ancient history, and I have much reluctance in pursuing the discussion of it, it is hoped that the long distance which separates me from the editorial room will be sufficient apology for asking your indulgence at this late day in order to register a protest against the conclusions enunciated in that letter.

I regret having to acknowledge that, to me, the letter appears of the nature of a *lucus a non lucendo*. If Dr. Ramsauer advances as a theory, well substantiated by experiment, that ultra-violet solar radiation is the chief source of condensation nuclei in the atmosphere, and cites in support of his theory diminished ultra-violet radiation and a hot and dry summer, with clear skies, in the northern hemisphere during 1911; and if, upon learning that, simultaneously with the existence of drought conditions in the north, there was excessive precipitation in the southern hemisphere, he can conclude that his theory is thereby fortified, in fact, universally confirmed, then he surely owes it to science to support this conclusion by convincing evidence. This should be something more than a mere supposition that the aqueous vapour which diffused into the hot summer atmosphere of the north, not encountering in the free air proper vehicles (provided by solar ultraviolet waves) for returning to the earth's surface, thereupon rushed to the southern hemisphere, where, in lieu of condensation nuclei provided by solar ultraviolet waves, it was pleased to avail itself of the facilities afforded by the ordinary laws governing gaseous bodies in order to get back to *terra firma*. According to what Dr. Shaw has written, it is evident that the laws of gases operated with full vigour in the northern hemisphere during the summer of 1911.

If, as Dr. Ramsauer contends, ultra-violet solar radiation is the *chief source* of condensation nuclei, and if normal ultra-violet radiation is a necessary condition for normal precipitation of aqueous vapour from the atmosphere, and if during periods of diminished activity in this part of the solar spectrum we are to expect the heaviest precipitation over one-half of the world, then it logically follows that the existence *in excess* of condensation nuclei produced by ultra-violet solar rays is a preventive of rain.

Not to pursue farther for the moment this function of ultra-violet radiation, it may be confidently stated that orthodox meteorologists will view with suspicion the simple conception of rapid and general distribution of vapour through the atmosphere embraced in Dr. Ramsauer's supposition. According to a well-established law of physics, the quantity of vapour which may exist in a given space is conditioned upon the temperature of the vapour and the pressure exerted upon it; consequently, in speaking of the aqueous vapour of the atmosphere, it may be said, without widely deviating from the truth, that the temperature of a given volume of air is the controlling factor determining the quantity of vapour which may exist therein. It has been well established by observation that the spontaneous diffusion of vapour in the air is a rather slow process, and that its general distribution through the atmosphere is chiefly effected by the winds and the currents of the general planetary circulation.

Dr. Ramsauer suggests no explanation as to the manner in which the vapour from the northern was translated to the southern hemisphere. The assumption that it was by the process of diffusion implies supersaturation in the upper air; and as to that condition we must hold, with Dr. Shaw, "that it has never been demonstrated." Numerous observations in the lofty atmosphere made in practically all parts of the world, by means of balloons and kites, show that the quantity of vapour decreases in nearly a geometrical progression as the elevation above the surface increases arithmetically, so that even at a moderate height a region is reached in which the water equivalent of its vapour content may conveniently be expressed in barrels instead of billions of tons—a quantity inadequate to account for excessive rains over a large portion of the earth. With such free distribution of vapour in the atmosphere as Dr. Ramsauer suggests, it would be difficult to account for the arid regions of the earth; since atmospheric overturnings are most frequent and most violent over such regions, enough vapour would be condensed to convert them into fertile regions. Indeed, the arid regions furnish evidence of the most conclusive kind that the lowest stratum of the atmosphere constitutes the "physical laboratory where rains and dense clouds are made," since they are all flanked to windward by mountain barriers which abstract the life-giving vapour from the air.

It is highly probable that during the earth's dawn the vapour of the atmosphere was saturated, as it is supposed to be now on Venus, but the irregularities introduced by continental upheavals have been the means of draining the moisture to such an extent that the air over all continental interiors and in all regions high aloft is now prevailingly dry.

If it be assumed that a mere preponderance of vapour over a given region would cause a rapid outflow to regions where the air is less charged, then there might arise a number of complicated conditions much more difficult to explain than the "weather of 1911." For instance, to cite an extreme case, the mean vapour tension over the desert of Sahara is about the same as that over central Europe and southern England; consequently it must be in excess over the desert during probably half the time, and it might therefore be concluded that much of the rain and verdure of central Europe and England is due to the vapour coming to those regions from the heart of the African desert. The relative conditions over Europe and the desert are chronically similar to those which characterised the weather of Europe and South America during 1911.

If the semi-annual exchange of vapour between the hemispheres really took place, as suggested by Dr. Ramsauer, it would probably cause disaster throughout the northern half of the world during periods of diminished ultra-violet radiation. For while the southern hemisphere might easily accommodate the vapour emanating from the limited water surfaces during the northern summer, six months later, with the boundless southern oceans seething under the perihelion sun, the quantity of vapour sent across the equator would quickly impart a decidedly martian aspect to the northern hemisphere.

In discussions of summer weather, an important physical fact is generally overlooked, one which is rarely referred to with proper stress even in treatises on meteorology, viz. the remarkable increase in the tension of saturated aqueous vapour after passing the temperature of 30° C. The energy of solar rays falling upon the ocean surfaces, the chief source of vapour supply, is almost wholly used up in converting the water into a gaseous state, so that the temperature of the water surface varies but slightly during a season; whereas the energy of the rays falling on land areas is chiefly exhausted in heating the soil and dust particles suspended in the air, and thus indirectly heating the air in contact with those solid bodies and causing land temperatures in the lower atmosphere to vary through wide limits. So, while the ocean gives off a nearly constant supply of vapour at a uniform and relatively low temperature during the summer, the so-called capacity of the continental air for vapour increases enormously once the midsummer temperatures are reached, making it increasingly difficult for atmospheric overturnings to bring about condensation unless rains have been sufficiently distributed over the land during the late spring and early summer to compensate for this large saturation deficit which would otherwise be caused by intense solstitial insolation.

This relation between temperature and vapour tension sufficiently explains the barren islands of tropical mid-oceans, as well as the clear skies and "dry spells" of the great majority of summers; and it also points to the red end as the portion of the solar spectrum chiefly responsible for "the weather of 1911."

I have no desire to question the statement that ultra-violet rays do produce condensation nuclei; the portion of Dr. Ramsauer's first letter which struck me as open to debate is the statement that ultra-violet solar radiation is the *chief source* of condensation nuclei in the atmosphere. One of the ablest investigators of the day has recently said, in treating of another branch of terrestrial physics, "it is in any case to observation that we must turn as the touchstone by which to try theory." During the past nine years I have made many observations of the relative intensity of ultra-violet solar radiation in the northern hemisphere, on the ocean, and in the southern hemisphere, with the hope of witnessing some phenomenon in nature that might furnish evidence of this power of ultra-violet rays so conclusive as the results obtained in laboratory experiments. Only once have I had reason to think (for a short time) that my efforts were being rewarded.

Although Dr. Ramsauer concludes that ultra-violet solar radiation was at a minimum phase during 1911, during the first half of March of that year I obtained the highest values for all the years of my measurements. About 10 a.m., March 11, just after the highest maximum had been recorded, a surprisingly sudden decrease in intensity was indicated by the actinometer; no cause for the change was discernible in the deep blue of a perfectly clear sky, and observations were repeated as rapidly as possible until 10.45 a.m., when the intensity had become very weak and filmy clouds could be seen in the zenith in an incipient stage of formation; by 11.30 the whole sky was overcast with an alto-stratus formation. During this time no change was registered in the brisk, warm, northerly wind which had been blowing since early morning, and the pressure, though slightly below normal, showed the normal variation for this time of day; so it seemed that the ultra-violet rays had at last displayed their powers in an unquestionable manner. But after the upward turn in the diurnal pressure curve set in, about 2 p.m., the barometer rose at an unusual rate, and by sunset a strong, cold, southerly wind was blowing, thus showing that the transformations in the upper air of the forenoon were due to the advance portion of a pressure wedge overflowing the warm and relatively moist surface current. It may be added here that no rain fell anywhere near the place of observation for several weeks after this display (although March is still well within the rainy season of this region), nor have I, up to the present time, heard of such general and heavy rains over the earth during the latter part of the month as would commensurate with such unusual activity in the ultra-violet field of the sun.

Dr. Ramsauer may claim that the mere fact of condensation is sufficient proof of his theory, and this brings up another matter referred to in his first letter which I shall discuss briefly. He says:—"If we neglect the purely local formation of nuclei in large centres of industry, the ultra-violet . . . radiation of the sun is chiefly responsible," &c., implying that condensation can take place only on an infinitely small number of the solid impurities sustained in the air. There are probably not so many factory chimneys on the whole continent of South America as there are in London, yet within the past few days an area of several hundred thousand square miles in the central section of this continent was covered by a shallow fog caused by dust particles, raised by the high winds of a "dry cyclone," cooling by radiation into the calm air of a rapidly following high-pressure area. This is only a single instance of a phenomenon which is very common indeed during the fall and winter in all regions of the temperate zones, and it goes to show that clean dust particles raised by the winds from virgin soils are quite as effective as condensation nuclei as the particles of waste products which escape through the chimneys of manufacturing towns. If dust particles can act so efficiently as nuclei in the low-lying strata, why should they be denied this agency when they appear in the higher regions of the atmosphere? For their existence in those regions, even far out into interplanetary space, is impressively evidenced by the brilliancy of the twilight glow, the meteor tracks, and the zodiacal light.

L. G. SCHULTZ.

Oficina Meteorológica Argentina, Observatorio Magnético, Pilar, Córdoba, July 26.

Antiquity of Neolithic Man.

RECENT excavations in St. Helier, Jersey, have brought to light the following evidence bearing on the antiquity of Neolithic man:—

The soil beneath the town of St. Helier is, in descending order, composed as follows:—

(1) A deposit of blown sand and recent alluvium from 4 ft. to 6 ft. thick.

(2) A bed of brown sandy and clayey peat (with relics of Gallo-Roman times).

(3) A marine deposit, consisting of clay, shingle, and shell-gravel, from 2 ft. to 5 ft. thick.

(4) A bed of firm black peat and forest remains which ranges from 5 ft. to 14 ft. in thickness.

This peat and forest bed is traceable to the shore, where it forms the well-known "submerged forest," thence (as revealed by the dredge) across the channel that separates the island from the continent, and along the continental coast from Cape La Hague to Finisterre.

This no doubt is all one with the post-glacial submerged forests of the British Isles and north-western Europe in general, for all through the flora and fauna are the same, viz. oak, alder, birch, hazel, Juncus, and Equisetum, with hazel nuts in profusion. *Bos longifrons*, red deer, and wolf, even elytra of the little purplish-green beetle, *Geotropus vernalis*, are present in this layer beneath St. Helier, as they are from extreme north to south throughout the vast forest area.

This deposit, then, marks the period of the commencement of land elevation which followed the subsidence of glacial times, for it lies immediately upon unmistakable rubble-drift and blue marine clay.

Neolithic relics, in the way of stone implements and fragments of pottery, are very plentiful on the surface, and in the upper levels, of this forest bed, but, so far as I can ascertain, have never been recorded from the strata beneath.

In a series of excavations now in progress for the foundations of a building in St. Helier, the strata as above described have been cut through, and in the blue clay *beneath the forest bed* (which here is 8 ft. thick) were found Neolithic implements as follows:—(1) A squared block of diorite about 6 in. in width and in breadth, and about 2 in. thick, which has been used as an anvil, apparently for chipping flints. It is deeply scored on both sides. (2) A flat sandstone pebble about 3 in. in diameter, which has been used in the same way. (3) A flat pebble of dolerite about a foot in length, 4 in. wide at one end, and running to a point at the other.

This pebble has served three purposes, for it is worn and abraded on the broad and fairly sharp end, showing that it has been used as an axe; again, on the sharpest lateral edge, indicating use as an ordinary meat-chopper; finally, it is scored with many cuts on the flat surfaces, having apparently been used as an anvil for chipping flints. (4) Two good specimens of the very typical flat pebble implements of elongated triangular form, bevelled at the broad end—a crude form of implement which has persisted until the dolmen period, and occurs plentifully amongst the latest Neolithic relics.

Besides these there were numerous flint chippings, cores from which flakes had been struck, and some crude flint implements with no characteristic detail.

In the same stratum as these, and in a layer of yellow clay which lies beneath, flint implements of decided Chellian, Acheulian, and Mousterian types are frequent, but the relics above specified are very clearly and decidedly Neolithic.

As the portion of the forest bed at this spot must represent the vegetation that first fringed the land as it recovered from the depression of glacial times, and these relics lie beneath it, we cannot but conclude that the Neolithic races date from a period far more remote than has usually been assigned to them, and that they must, in fact, date back nearly into the last glacial period.

Question may arise as to the possibility of a disturbance of the area by floods or other agencies, and the possible mixing up of the relics, but the excavations have been closely watched and studied by myself and several fellow-members of the local Archæological Society, and if there is one point clearer than another it is that there has been no such disturbance. The tree stumps in the overlying forest bed are as they grew, with their roots passing into the underlying strata, and everything indicates quiescence. Nor could the objects have sunk through the peat, for of the abundant stones in the overlying deposits, none have even penetrated the surface; the material is too compact to admit of this.

These interesting relics now form part of the extensive and ever-growing collection in the museum of the local Archæological and Antiquarian Society, the Société Jersiaise.

It would be interesting to know if any of your numerous archæological readers have found evidences of Neolithic man at this geological horizon.

Jersey, August 28. J. SINEL.

The Structure of the Ciliary and Iris Muscles in Birds.

MAY I be allowed through your columns to direct the attention of physiologists and anatomists to certain special features in ocular accommodation, and in the movements of the iris in birds, and to a peculiarity of the ciliary muscle and sphincter of the pupil, which, so far as I have been able to ascertain, has not been previously described?

If the eye of any bird in which a light-coloured iris sharply contrasts with a black pupil be carefully watched, rapid changes in the size of the pupillary opening may be sometimes observed to take place during the few moments that the bird is fixedly looking at any object under the same intensity of illumination. Moreover, the character of these movements strongly suggests that they are under voluntary control.

The pupillary reaction to light is very rapid in birds; the recontraction following the transient dilation which accompanies the momentary closing and opening of the eyelids and nictitating membrane in the movement of blinking is so rapid that the contraction of the pupil seems to coincide with the re-opening of the eye, and not definitely to follow it as in man.

Atropine seems to have no effect in dilating, or Eserin in contracting, the pupil; neither does the former seem to affect accommodation in birds.

In connection with these facts it is also interesting to find that the ciliary muscle and the sphincter of the pupil in birds are both composed of striated fibres of the voluntary type, and not of plain unstriped muscle fibres as in man and other animals.

Thus, while in man with binocular vision the delicate movements of accommodation and the associated movements of the pupil are carried out by involuntary muscles, in birds, in which in many species vision is of the monocular type, the same movements are performed by voluntary muscles.

The extremely accurate and rapid movements of the beak in birds no doubt require a corresponding delicacy and rapidity of ocular accommodation at very short range.

Other interesting questions arise as to the representation of these intrinsic eye movements in the avian brain. The matter is also one of phylogenetic interest, and I hope to publish further histological details with photomicrographs of sections shortly. C. J. BOND.

Leicester, August 30.

The Attacks of Birds upon Butterflies.

MR. EVERSHED'S letter in NATURE of August 29 seems to me very suggestive, and it is to be hoped that his hypothesis may be tested by careful observation in many parts of the world. As regards the rarity with which these attacks have been witnessed in India by Mr. Evershed and many other naturalists, it is well to bear in mind the probability that the proportion of butterfly-eating birds differs in the different tropical regions. Indeed, it is difficult on any other hypothesis to understand why butterfly mimicry should be developed to such very different degrees in the three richest regions, being transcendent in the Neotropical, remarkable in the Ethiopian, but relatively poor in the Oriental region. Indirect evidence of the frequency of attacks in different areas might perhaps be obtained by a study of the relative amount of damage which could only have been inflicted by the beak of a bird. E. B. POULTON.

St. Helens, Isle of Wight, August 26.

A Flower-sanctuary.

IN reply to Sir Edward Fry's inquiry (NATURE, August 29, p. 661) as to the powers of county councils to protect particular flowers, I am now enabled, through the courtesy of the clerk to the Cornwall County Council, to send a copy of the by-law referred to; it is given below. It is obvious that the Somerset County Council must possess the same powers as the Cornwall County Council, and that a by-law on these lines would meet the requirements of the case, and I venture to hope that Sir Edward Fry will exert his influence in favour of the enactment of such a by-law.

FRANK H. PERRYCOSTE.

Higher Shute Cottage, Polperro, Cornwall, September 12.

County of Cornwall.—By-law for the Good Rule and Government of the Administrative County of Cornwall, made in pursuance of the Local Government Act, 1888, by the County Council of the said County, at a meeting held at Truro, on the 6th day of November, 1906, at which not less than two-thirds of the whole number of the Council were present:—

"No person shall (unless authorised by the owner or occupier, if any, or by law so to do) uproot or destroy any Ferns or other Wild Plants growing in any road, lane, roadside, waste, wayside bank or hedge, common, or other public place, in such a manner or in such quantities, as to damage or disfigure any such road, lane, roadside waste, wayside bank, or hedge, common or other public place. Provided that this by-law shall not apply to persons collecting specimens in small quantities for private or scientific use.

"Any person offending against this by-law shall be liable to a penalty not exceeding five pounds."

THE SUMMER OF 1912.

THE summer of 1912 has proved so thoroughly unsummerlike, and has been so marked a contrast to the abnormally fine and hot summer of 1911, that a few facts may be of interest. The period dealt with will be limited to the three months June, July, and August.

The drought experienced in April, followed by a general deficiency of rain in May, rendered the early summer rains in June agreeable rather than otherwise, but the wet weather soon became too persistent, and the frequent rains have been a special feature of the past summer. With the exception of a period of eight days, July 10 to 17, the weather throughout was unusually cold, and this was really the only dry period experienced over the country generally.

The following table gives the summary of temperature, rainfall, and duration of bright sunshine issued by the Meteorological Office for the several districts of the United Kingdom for the past summer (thirteen weeks ended August 31), and the corresponding results for the summer of last year have been added:—

District	Temperature: Accumulated number of day degrees above 42°		Rainfall: No. of days with rain		Rainfall: Total fall		Sunshine: Hours recorded	
	1912	1911	1912	1911	1912	1911	1912	1911
					In.	In.		
Scotland, North . .	997	1211	56	53	10·38	10·62	291	476
Eastern								
Scotland, East . . .	1063	1370	57	43	10·18	5·78	237	574
England, North-east	1284	1679	65	34	12·86	6·64	309	663
England, East . . .	1553	1911	57	29	12·25	3·83	473	759
Midland Counties .	1371	1832	60	28	13·28	4·13	346	687
England, South-east	1524	1940	55	24	10·58	3·32	473	838
Western								
Scotland, West .	1213	1477	58	49	12·45	8·28	364	631
England, North-west	1314	1681	64	39	13·83	6·74	364	705
England, South-west	1369	1829	65	29	16·74	5·57	382	772
Ireland, North . . .	1105	1461	62	45	13·27	7·29	355	565
Ireland, South . . .	1237	1679	70	43	15·04	7·52	373	622
English Channel . .	1510	1929	65	27	14·21	5·49	510	861

The foregoing table shows that the highest temperature during the past summer occurred in the east and south-east of England and in the Channel Islands, and the temperature for the recent summer is largely in defect of that last year in all districts. In the Midland counties and in the south-west of England the day degrees above 42° are respectively 461 and 460 less than last year, which gives a deficiency of temperature of 5° for the whole period compared with 1911. The deficiency of temperature this summer compared with that of 1911 exceeds 4° in all the English districts except in the east of England, where it amounts to 3·9°.

The exceptionally heavy rains of August have greatly augmented the aggregate rainfall for the past summer over nearly the whole of Great Britain. At Darwen the fall for the month was 11·10 in. and at Norwich 10·50 in., the latter being more than four times the average; of the large total at Norwich 7·34 in. fell in the twenty-nine hours ending 9 a.m. August 27, and similar falls in the neighbourhood resulted in exceptionally severe floods. At Kew, the London reporting station of the Meteorological Office, the aggregate rainfall for August was 5·18 in., which is more than double the average, and it has only been exceeded once in August in the last fifty-seven years, 6·50 in. being measured in 1878; and there were only two days, the 1st and the 9th, absolutely without rain during the month.

The number of rainy days for the past summer is more in excess of the normal in the English districts than elsewhere, whilst the quantity of rain is largely in excess everywhere except in the north of Scotland, where it is seen from the table that the aggregate rainfall for the three months was less than in 1911.

The returns for the summer show that the heaviest rainfall occurred in the south-west of England, where the measurement was 16·74 in., which is 8·17 in. more than the average of the last twenty-five years. In the Channel Islands the excess was 7·45 in., and in the Midland counties 6·23 in. The rainfall for the closing week of the season amounted to more than seven times the average in the east of England.

The duration of bright sunshine was everywhere largely deficient, and the table shows that the amount in the several districts is only about one-half of that for the corresponding season in 1911.

The following results from the Greenwich observations exhibit in a very striking manner the exceptional character of the past summer, and the results for the summer of 1911 are also given to show the contrast:—

Period	Temperature: Mean max. or highest day			Temperature: Mean min. or lowest night			Rainfall: Days with rain		Rainfall: Total		Sunshine: No. of hours	
	1912	1911	Avge. 70 Years	1912	1911	Avge. 70 Years	1912	1911	1912	1911	1912	1911
	°	°		°	°	°			In.	In.		
June . .	70	71	71	50	50	50	18	12	2·34	2·11	219	224
July . .	75	81	74	55	55	53	11	3	1·25	0·26	164	335
August .	67	81	73	51	57	53	26	8	4·38	1·35	114	260
Summer .	71	78	73	52	54	52	55	23	7·97	3·72	497	819

It is seen that August is in every way the most exceptional of the three recent summer months. The mean of the day temperatures is 14° lower than in August, 1911, and the mean of the night temperatures is 6° lower. There were only five days without measurable rain, both the rainy days and the amount being more than three times as great as in 1911, whilst the duration of bright sunshine was less than one-half.

There were twelve days in the past summer with a shade temperature of 80° and above, whilst in the summer of 1911 there were thirty-seven such warm days, the average for the last seventy years being thirteen days. There were forty-five days this summer with the temperature 70° or above, and in the summer of 1911 there were seventy-three days with that temperature, the average for the past seventy years being fifty-nine days. The highest shade temperature in August this year was 73°, whilst in August last year it rose to 100°, the reading being a record for Greenwich.

The controlling factor of the weather over the British Isles during the past summer has been the unusual distribution of atmospheric pressure in our neighbourhood. During almost the whole of the summer a region of high barometer has been situated in the Atlantic to the south-west of our area, and a second region has been situated either over Iceland or Scandinavia. This has left a free passage over the British Isles for incoming disturbances from the Atlantic, and these have become imprisoned within our area, moving very sluggishly on their easterly track, and at times remaining practically stationary.

A feature of especial interest due to the unusual wind circulation set up by the abnormal atmospheric distribution was the exceptionally high temperatures which prevailed over Scandinavia during the first half of August, whilst in the British Isles and in other parts of western Europe the weather was peculiarly dull and cold. For the week ending August 12, the mean of the maxima or highest day readings at Haparanda was 80°, at Bodö 74°, and in London and at Jersey 63°; whilst at Lisbon the mean was only 76°, and at Nice 78°.

The temperature of the sea-surface in the North Atlantic and in proximity to our coasts has for some time past been much below the average.

Chas. Harding.

CHIRIQUIAN ANTIQUITIES.[1]

PROF. G. G. MacCURDY, of Yale University, has taken advantage of the fine collection of antiquities from Chiriqui under his charge to present to students a very valuable and interesting monograph, which is illustrated, in the usual lavish and artistic manner of our colleagues in the United States of America, by 384 figures in the text, 49 plates (five of which are coloured), and a map. The ancient cultured people of Chiriqui are apparently represented by the Guaymi, whose language shows affinity with that of the Chibcha of Colombia. The area now occupied by the republics of Colombia and Panama formed a linguistic and archæological barrier between the great civilisations of Mexico and Peru. In this culture zone the dominant factor is Chibchan; on the other hand, the ancient art of Chiriqui was influenced more by Mexico than by the south, but the Chiriquian culture was distinctively indigenous, and radiated into southern Costa Rica.

Attention is directed throughout the memoir to the general phylogenetic trend in the development of Chiriquian art as a whole. The elegant stone vessels carved in the form of a jaguar are traced back to an oval prototype with a hollow pedestal; with the exception of architecture, the stone art of Chiriqui compares favourably with that of Mexico or Peru. The especial interest of Chiriquian pottery was first emphasised by Prof. W. H. Holmes (Sixth Ann. Rep. Bur. Am. Ethnol., 1888), and Dr. MacCurdy has with slight modifications adopted his classification. The pottery, especially the unpainted ware, is the connecting link between the products of the stone worker and artificer in metal. The "prototype was presumably the calabash. Aside from this, the plant world had practically no influence on the elaboration of form and ornament." The unpainted ware includes the terra-cotta or biscuit group, or, as MacCurdy prefers to call it, the armadillo group, as its ornamentation is mainly based on the armadillo, and three smaller groups.

The painted ware consists of ten groups, of which the fish or tripod, lost colour, alligator, and polychrome groups are the most important (Fig. 1). As might be anticipated, the introduction of colour as a decorative factor often tended to minimise the importance of incised and plastic features; the armadillo and serpent are practically never executed in paint, while incised or plastic motives derived from the alligator are equally rare. Very characteristic of Chiriquian pottery is the presence of three hollow legs, provided with long slits and containing pellets, which serve as a rattle; most of these in the painted ware have a fish ornamentation. The lost colour process was confined to a single, rather large, group of ware; it consisted of tracing the design in wax, the application of a solid coat of black paint over the area to be decorated, and immersing the vessel in hot water, which melted the wax, the design part that was waxed thus showing up light. An analogous method is employed in Java for decorating sarongs.

In the alligator group the designs are always on a pale yellow slip; black and red are the delineating colours. As a matter of fact, it is the crocodile, and not the alligator, which is depicted. The modifications which occur in the form of the crocodile or of parts of it constitute a very pretty

Fig. 1.—Polychrome ware. Vase of eccentric form, the chief ornamental feature being the elaborate branching scroll filling each of the two shoulder panels; the engaged crocodile motives are easily distinguished.

example of the conventionalisation of designs. The highest technical excellence was achieved in the polychrome group; here a purple colour was introduced derived from a non-ferruginous metallic oxide, and not from the *Purpura patula*, which was used to dye cotton thread; it is also characterised by elegant scroll designs derived from crocodiles. The gold Chiriquian figurines are famous, and are here treated adequately for the first time. Squier (1859) says he "was informed by the late Governor of the Bank of England that several thousand pounds' worth were annually remitted from the Isthmus as bullion to that establishment," where they were melted down.

A. C. Haddon.

[1] "A Study of Chiriquian Antiquities." By Prof. G. G. MacCurdy. (Memoirs of the Connecticut Academy of Arts and Sciences, vol. iii., March, 1911.) Pp. xx+249+xlix plates. (New Haven, Conn.: Yale University Press, 1911.)

THE BRITISH ASSOCIATION AT DUNDEE.

ONE of the most successful meetings of the British Association in recent years, and the largest since the Cambridge meeting of 1904, when the total attendance was 2789, in comparison with about 2500 at Dundee, was brought to a close as we went to press last week. A distinguishing and pleasing characteristic of the meeting was the interest taken in scientific questions by the people of Dundee and the neighbourhood; and to this interest may perhaps be attributed the generous provision made privately for visitors.

In proposing a cordial vote of thanks to the Lord Provost, Magistrates, and Town Council of Dundee for this unbounded hospitality, at the closing meeting on September 11, the President, Prof. Schäfer, rightly remarked that though he had attended many meetings of the Association, he did not think that on any occasion had a more cordial welcome been extended than that enjoyed at Dundee. He could certainly say that the Association had never been entertained more royally or hospitably.

Lord Provost Urquhart, in acknowledging the vote of thanks, said that from the time the suggestion was first made by Prof. D'Arcy Thompson that it might be possible to have a visit from the British Association, the citizens had responded most enthusiastically. The providing of hospitality had been a problem owing to the limited hotel accommodation in the city, but the local committee had, he hoped, been able to solve it to the satisfaction of the visitors.

Sir William White, the President-elect, proposed thanks to the Council of University College, the governing bodies of the Chamber of Commerce, Technical College, and other institutions for their kindness in placing their buildings and resources at the disposal of the Association.

Principal Griffiths moved a vote of thanks to the Provost and Magistrates of the burghs of St. Andrews, Dunfermline, and Arbroath, and to all who had contributed by means of excursions, garden-parties, and in other ways to the entertainment of the members. Finally, Prof. Perry, the general treasurer, expressed the thanks of the Association to the local officers and executive for the admirable arrangements they had made, and remarked that it was the best engineered meeting he had attended in forty years.

At the meeting of the General Committee on September 11, the following resolutions submitted by the sections named were adopted:—

Mathematical and Physical Science.—(1) That it be recommended to the General Committee that the cordial thanks of the Association be forwarded to the *Falmouth* Committee for their valuable services since their appointment in 1901; and especially to their chairman, Sir William Preece, and the secretaries, Dr. R. T. Glazebook and Dr. W. N. Shaw.

That, having regard to the importance of the observations at Falmouth in the work of the previous survey and in other work in connection with terrestrial magnetism and meteorology, steps be taken to assist an appeal for a Treasury grant, in order that the observatory at Falmouth may be efficiently maintained.

(2) That it is desirable that a detailed magnetic survey of the British Isles, on the lines of that of Profs. Rucker and Thorpe for the epoch of 1891, should now be repeated, in order to answer the question as to the local variations of the terrestrial magnetic elements within twenty-five years.

That a representation to this effect be made to the Royal Society, the Admiralty, the Ordnance Survey, and the Meteorological Committee.

Zoology.—The British Association for the Advancement of Science deplores the rapid destruction of fauna and flora throughout the world, and regards it as an urgent duty that immediate steps be taken to secure the preservation of all kinds of animals and plants, irrespective of their economic or sporting value.

Anthropology.—That the copies of the fourth edition of "Notes and Queries in Anthropology," now on the point of publication through the committee appointed for the purpose of its preparation, be delivered as heretofore to the Royal Anthropological Institute for sale to its members and to the public, the proceeds to be reserved at the disposal of the Association towards the expenses of any future editions, and accounts of the sales to be submitted to the general treasurer of the Association on demand.

Papers to be printed *in extenso*:—Dr. J. V. Eyre, "Report on Solubility," part ii.; Sir John Macdonald, "The Road Problem."

A sum of 1036*l.* 18*s.* 8*d.* was appropriated for scientific purposes by the committee. Subjoined is a synopsis of the subjects for which the grants are made, and the names of chairmen of the committees:—

Mathematical and Physical Science.

Prof. H. H. Turner, seismological observations ...	£60 0 0	
Dr. W. N. Shaw, upper atmosphere	50 0 0	
Sir W. Ramsay, grant to the International Commission on Physical and Chemical Constants	40 0 0	
Prof. M. J. M. Hill, tabulation of Bessel functions ...	30 0 0	
		£180 0 0

Chemistry.

Dr. W. H. Perkin, study of hydro-aromatic substances	20 0 0	
Prof. H. E. Armstrong, dynamic isomerism ...	30 0 0	
Prof. F. S. Kipping, transformation of aromatic nitroamines	20 0 0	
A. D. Hall, plant enzymes	30 0 0	
		£100 0 0

Geology.

R. H. Tiddeman, erratic blocks	5 0 0	
Prof. W. W. Watts, igneous and associated sedimentary rocks of Glensaul	10 0 0	
Prof. P. F. Kendall, list of characteristic fossils ...	5 0 0	
Dr. J. Horne, Old Red Sandstone of Dura Den ...	75 0 0	
Dr. A. Strachan, Ramsay Island, Pembroke	10 0 0	
Prof. Grenville Cole, Old Red Sandstone of Kiltorcan ...	15 0 0	
		£120 0 0

Zoology.

Prof. S. J. Hickson, table at the Zoological Station at Naples	30 0 0	
Dr. A. E. Shipley, Belmullet Whaling Station	15 0 0	
Dr. Chalmers Mitchell, nomenclator animalium genera et subgenera ...	100 0 0	
		£145 0 0

Engineering.				
Sir W. H. Preece, gaseous explosions	80	0	0	
				£80 0 0
Anthropology.				
Dr. R. Munro, Glastonbury Lake Village	5	0	0	
C. H. Read, age of stone circles	2	2	2	
Dr. R. Munro, artificial islands in Highland lochs	5	0	0	
Prof. G. Elliot Smith, physical character of ancient Egyptians	34	16	6	
Prof. A. Thomson, anthropometric investigations in British Isles	5	0	0	
Prof. W. Ridgeway, Roman sites in Britain	15	0	0	
Prof. W. Ridgeway, excavations in Macedonia	30	0	0	
E. S. Hartland, Hausa manuscripts	20	0	0	
				£116 18 8
Physiology.				
Prof. E. A. Schäfer, the ductless glands	40	0	0	
Prof. S. J. Hickson, table at the Zoological Station at Naples	20	0	0	
Prof. J. S. Macdonald, calorimetric observations	45	0	0	
Prof. Starling, oxy-hæmoglobin	15	0	0	
Prof. F. Gotch, mammalian heart	20	0	0	
				£140 0 0
Botany.				
Dr. D. H. Scott, structure of fossil plants	15	0	0	
Prof. A. C. Seward, Jurassic flora of Yorkshire	15	0	0	
Prof. F. Keeble, flora of peat of Kennet Valley	15	0	0	
A. G. Tansley, vegetation of Ditcham Park	45	0	0	
				£90 0 0
Education.				
Prof. J. J. Findlay, mental and physical factors ...	20	0	0	
Dr. G. A. Auden, influence of school books on eyesight ...	15	0	0	
Sir H. Miers, scholarships, &c., held by University students	5	0	0	
				£40 0 0
Corresponding Societies Committee.				
W. Whitaker, for preparation of report	25	0	0	
				£25 0 0
Total				£1036 18 8

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY P. CHALMERS MITCHELL, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

Zoological Gardens and the Preservation of Fauna.

IN thinking over possible subjects for this Presidential Address, I was strongly tempted to enter on a discussion of the logical methods and concepts that we employ in zoology. The temptation was specially strong to a Scot, speaking in Scotland, that he should devote the hour when the prestige of the presidential chair secured him attention, to putting his audience right on logic and metaphysics. But I reflected that zoology is doing very well, however its logic be wavering, and that as all lines subtend an equal angle at infinity, it would be of small moment if I were to postpone my remarks on metaphysics. And so I am to essay a more modest but a more urgent theme, and ask you to consider the danger that threatens the surviving land-fauna of this globe. A well-known example may serve to remind you how swift is the course of destruction. In 1867, when the British Association last met at Dundee, there were still millions of bison roaming over the prairies and forests of North America. In that year the building of the Union Pacific, the first great trans-continental railway, cut the herd in two. The southern division, consisting itself of several million individuals, was wiped out between 1871 and 1874, and the practical destruction of the northern herd was completed between 1880 and 1884. At present there are only two herds of wild bison in existence. In the Yellowstone Park only about twenty individuals remained in 1911, the greater part of the herd having been killed by poachers. A larger number, more than three hundred, still survive near the Great Slave Lake, and there are probably nearly two thousand in captivity, in various zoological gardens, private domains and State parks. It is only by the deliberate and conscious interference of man that the evil wrought by man has been arrested.

A second example that I may select is also taken from the continent of North America, but it is specially notable because it is sometimes urged, as in India, that migratory birds require no protection. Audubon relates that just a century ago passenger pigeons existed in countless millions, and that for four days at a time the sky was black with the stream of migration. The final extinction of this species has taken place since the last meeting of the Association in Dundee. In 1906 there were actually five single birds living, all of which had been bred in captivity, and I understand that these last survivors of a prolific species are now dead, although the birds ranged in countless numbers over a great continent.

It would be futile to discuss in detail the precise agencies by which the destruction of animal life is wrought, or the pretexts or excuses for them. The most potent factors are the perfection of the modern firearm and the enormous increase in its use by civilised and barbarous man. Sometimes the pretext is sport, sometimes wanton destructiveness rules. The extermination of beasts of prey, the clearing of soil for stock or crops, the securing of meat, the commercial pursuit of hides and horns and of furs and feathers, all play their part. Farmers and settlers on the outskirts of civilisation accuse the natives, and allege that the problem would be solved were no firearms allowed to any but themselves. Sportsmen accuse other sportsmen, whom they declare to be no real sportsmen, and every person whose object is not sport. The great museums, in the name of science, and the rich amateur collectors press forward to secure the last specimens of moribund species.

But even apart from such deliberate and conscious agencies, the near presence of man is inhospitable to wild life. As he spreads over the earth, animals wither before him, driven from their haunts, deprived of their food, perishing from new diseases. It is part of a general biological process. From time to time, in the past history of the world, a species, favoured by some happy kink of structure or fortunate accident of adaptability, has become dominant. It has increased greatly in numbers, outrunning its natal bounds, and has radiated in every possible direction, conquering woodland and prairies, the hills and the plains, transcending barriers that had seemed impassable, and perhaps itself breaking up into new local races and varieties. It must be long since such a triumphant progress was unattended by death and destruction. When the first terrestrial animals crept out of their marshes into the clean air of the dry land, they had only plants and the avenging pressure of physical forces to overcome. But when the Amphibians were beaten by the Reptiles, and when from amongst the Reptiles some insignificant species acquired the prodigious possibility of transformation to Mammals, and still more when amongst the Mammals Eutherian succeeded Marsupial, Carnivore the Creodont, and Man the Ape, it could have been only after a fatal contest that the newcomers triumphed. The struggle, we must suppose, was at first most acute between animals and their nearest inferior allies, as similarity of needs brings about the keenest competition, but it must afterwards have been extended against lower and lower occupants of the coveted territory.

The human race has for long been the dominant terrestrial species, and man has a wider capacity for adaptation to different environments, and an infinitely greater power of transcending geographical barriers than have been enjoyed by any other set of animals. For a considerable time many of the more primitive tribes, especially before the advent of firearms, had settled down into a kind of natural equilibrium with the local mammalian fauna, but these tribes have been first driven to a keener competition with the lower animals, and then, in most parts of the world, have themselves been forced almost or completely out of existence. The resourceful and aggressive higher races have now reached into the remotest parts of the earth and have become the exterminators. It must now be the work of the most intelligent and provident amongst us to arrest this course of destruction, and to preserve what remains.

In Europe, unfortunately, there is little left sufficiently large and important to excite the imagination. There is the European bison, which has been extinct in Western Europe for many centuries, whilst the last was killed in East Prussia in 1755. There remains a herd of about seven hundred in the forests of Lithuania, strictly protected by the Tsar, whilst there are truly wild animals, in considerable numbers, in the Caucasus, small captive herds on the private estates of the Tsar, the Duke of Pless and Count Potocki, and a few individuals in various zoological gardens. There is the beaver, formerly widespread in Europe, now one of the rarest of living mammals, and lingering in minute numbers in the Rhone, the Danube, in a few Russian rivers, and in protected areas in Scandinavia. The wolf and the bear have shrunk to the recesses of thick forests and the remotest mountains, gluttons to the most barren regions of the north. The chamois survives by favour of game-laws and the vast inaccessible areas to which it can retreat, but the mouflon of Corsica and Sardinia and the ibex in Spain are on the verge of extinction. Every little creature, from the otter, wild cat, and marten to the curious desman, is disappearing.

India contains the richest, the most varied, and, from many points of view, the most interesting part of the Asiatic fauna. Notwithstanding the teeming human population it has supported from time immemorial, the extent of its area, its dense forests and jungles, its magnificent series of river valleys, mountains, and hills have preserved until recent times a fauna rich in individuals and species. The most casual glance at the volumes by sportsmen and naturalists written forty or fifty years ago reveals the delight and wonder of travel in India so comparatively recently as the time when the Association last met in Dundee. Sir H. H. Johnston has borne witness that even in 1895 a journey "through almost any part of India was of absorbing interest to the naturalist." All is changed now, and there seems little doubt but that the devastation in the wonderful mammalian fauna has been wrought chiefly by British military officers and civilians, partly directly, and partly by their encouragement of the sporting instincts of the Mohammedan population and the native regiments, although the clearing of forests and the draining of marshlands have played an important contributory part. The tiger has no chance against the modern rifle. The one-horned rhinoceros has been nearly exterminated in Northern India and Assam. The magnificent gaur, one of the most splendid of living creatures, has been almost killed off throughout the limits of its range—southern Indian and the Malay Peninsula. Bears and wolves, wild dogs and leopards are persecuted remorselessly. Deer and antelope have been reduced to numbers that alarm even the most thoughtless sportsmen, and wild sheep and goats are being driven to the utmost limits of their range.

When I speak of the fauna of Africa, I am always being reminded of the huge and pathless areas of the Dark Continent, and assured that lions and leopards, elephants and giraffe still exist in countless numbers, nor do I forget the dim recesses of the tropical forests where creatures still lurk of which we have only the vaguest rumour. But we know that South Africa, less than fifty years ago, was a dream that surpassed the imagination of the most ardent hunter. And we know what it is now. It is traversed by railways, it has been rolled over by the devastations of war. The game that once covered the land in unnumbered millions is now either extinct, like the quagga and the black wildebeeste, or its scanty remnant lingers in a few reserves and on a few farms. The sportsman and the hunter have been driven to other parts of the continent, and I have no confidence in the future of the African fauna. The Mountains of the Moon are within range of a long vacation holiday. Civilisation is eating into the land from every side. All the great European countries are developing their African possessions. There are exploring expeditions, punitive expeditions, shooting and collecting expeditions. Railways are being pushed inland, water-routes opened up. The land is being patrolled and policed and taxed, and the wild animals are suffering. Let us go back for a moment to the Transvaal and consider what has happened since the Rand was opened, neglecting the reserves. Lions are nearly extinct. The hyæna has been trapped and shot and poisoned out of existence. The eland is extinct. The giraffe is extinct. The elephant is extinct. The rhinoceros is extinct. The buffalo is extinct. The bontebok, the red hartebeeste, the mountain zebra, the oribi, and the grysbok are so rare as to be practically extinct. And the same fate may at any time overtake the rest of Africa. The white man has learned to live in the tropics; he is mastering tropical diseases; he has need of the vegetable and mineral wealth that lie awaiting him, and although there is yet time to save the African fauna, it is in imminent peril.

When we turn to Australia, with its fauna of unique zoological interest, we come to a more advanced case of the same disease. In 1909 Mr. G. C. Shortridge, a very skilled collector, working for the British Museum, published in the Proceedings of the Zoological Society of London the results of an investigation he had carried out on the fauna of Western Australia south of the tropics, during the years 1904–7.

He gave a map showing the present and comparatively recent distribution for each of the species of Marsupials and Monotremes indigenous to that locality. West Australia as yet has been very much less affected by civilisation than Queensland, New South Wales, or Victoria, and yet in practically every case there was found evidence of an enormous recent restriction of the range of the species. Marsupials and Monotremes are, as you know, rather stupid animals, with small powers of adaptation to new conditions, and they are in the very gravest danger of complete extinction. In the island of Tasmania, the thylacine, or marsupial wolf, and the Tasmanian devil have unfortunately incurred the just hostility of the stock raiser and poultry farmer, and the date of their final extermination is approaching at a pace that must be reckoned by months rather than by years.

The development of the continent of North America has been one of the wonders of the history of the world, and we on this side of the Atlantic almost hold our breath as we try to realise the material wealth and splendour and the ardent intellectual and social progress that have turned the United States into an imperial nation. But we know what has happened to the American bison. We know the danger that threatens the pronghorn, one of the most isolated and interesting of living creatures, the Virginian deer, the mule-deer, and the bighorn sheep. Even in the wide recesses of Canada, the bighorn, the caribou, the elk, the wapiti, the white mountain goat, and the bears are being rapidly driven back by advancing civilisation. In South America less immediate danger seems to threaten the jaguar and maned wolf, the tapirs and ant-eaters and sloths, but the energy of the rejuvenated Latin races points to a huge encroachment of civilisation on wild nature at no distant date.

You will understand that I am giving examples and not a catalogue even of threatened terrestrial mammals. I have said nothing of the aquatic carnivores, nothing of birds, or of reptiles, or of batrachians and fishes. And to us who are zoologists, the vast destruction of invertebrate life, the sweeping out, as forests are cleared and the soil tilled, of innumerable species that are not even named or described is a real calamity. I do not wish to appeal to sentiment. Man is worth many sparrows; he is worth all the animal population of the globe, and if there were not room for both, the animals must go. I will pass no judgment on those who find the keenest pleasure of life in gratifying the primeval instinct of sport. I will admit that there is no better destiny for the lovely plumes of a rare bird than to enhance the beauty of a beautiful woman. I will accept the plea of those who prefer a well-established trinomial to a moribund species. But I do not admit the right of the present generation to careless indifference or to wanton destruction. Each generation is the guardian of the existing resources of the world; it has come into a great inheritance, but only as a trustee. We are learning to preserve the relics of early civilisations, and the rude remains of man's primitive arts and crafts. Every civilised nation spends great sums on painting and sculpture, on libraries and museums. Living animals are of older lineage, more perfect craftsmanship and greater beauty than any of the creations of man. And although we value the work of our forefathers, we do not doubt but that the generations yet unborn will produce their own artists and writers, who may equal or surpass the artists and writers of the past. But there is no resurrection or recovery of an extinct species, and it is not merely that here and there one species out of many is threatened, but that whole genera, families, and orders are in danger.

Now let me turn to what is being done and what has been done for the preservation of fauna. I must begin by saying, and this was one of the principal reasons for selecting the subject of my address, that we who are professional zoologists, systematists, anatomists, embryologists, and students of general biological problems, in this country at least, have not taken a sufficiently active part in the preservation of the realm of nature that provides the reason for our existence. The first and most practical step of world-wide importance was taken by a former president of the British Association, the late Lord Salisbury, one of the few in the long roll of English statesmen whose mind was attuned to science. In 1899 he arranged for a convention of the Great Powers interested in Africa to consider the preservation of what were curiously described as the "Wild Animals, Birds and Fish" of that continent. The convention, which did most important pioneer work, included amongst its members another president of this Association, Sir Ray Lankester, whom we hold in high honour in this section as the living zoologist who has taken the widest interest in every branch of zoology. But it was confined in its scope to creatures of economic or of sporting value. And from that time on the central authorities of the Great Powers and the local administrators, particularly in the case of tropical possessions, seem to have been influenced in the framing of their rules and regulations chiefly by the idea of preserving valuable game animals. Defining the number of each kind of game that can be killed, charging comparatively high sums for shooting-permits, and the establishment of temporary or permanent reserved tracts in which the game may recuperate, have been the principal methods selected. On these lines, narrow although they are, much valuable work has been done, and the parts of the world where unrestricted shooting is still possible are rapidly being limited. I may take the proposed new Game Act of our Indian Empire, which has recently been explained, and to a certain extent criticised, in the Proceedings of the Zoological Society of London, by Mr. E. P. Stebbing, an enlightened sportsman-naturalist, as an example of the efforts that are being made in this direction, and of their limitations.

The Act is to apply to all India, but much initiative is left to local governments as to the definition of the important words "game" and "large animal." The Act, however, declares what the words are to mean in the absence of such local definitions, and it is a fair assumption that local interpretations will not depart widely from the lead given by the central authority. Game is to include the following in their wild state:—Pigeons, sandgrouse, peafowl, junglefowl, pheasants, partridges, quail, spurfowl, florican and their congeners; geese, ducks and their congeners; woodcock and snipe. So much for birds. Mammals include hares and "large animals" defined as "all kinds of rhinoceros, buffalo, bison, oxen; all kinds of sheep, goats, antelopes and their congeners; all kinds of gazelle and deer."

The Act does not affect the pursuit, capture, or killing of game by non-commissioned officers or soldiers on whose behalf regulations have been made, or of any animal for which a reward may be claimed from Government, of any large animal in self-defence, or of any large animal by a cultivator or his servants, whose crops it is injuring. Nor does it affect anything done under licence for possessing arms and ammunition to protect crops, or for destroying dangerous animals, under the Indian Arms Act. Then follow prohibitory provisions, all of which refer to the killing or to the sale or possession of game or fish, and provisions as to licences for sportsmen, the sums to be paid for which are merely nominal, but which carry restrictions as to the number of head that may be killed. I need not enter upon detailed criticism as to the vagueness of this Act from the zoological point of view, or as to the very large loopholes which its provisions leave to civil and military sportsmen; these have been excellently set forth by Mr. Stebbing, who has full knowledge of the special conditions which exist in India. What I desire to point out is that it conceives of animals as game rather than as animals, and that it does not even contemplate the possibility of the protection of birds of prey and beasts of prey, and still less of the enormous number of species of animals that have no sporting or economic value.

Mr. Stebbing's article also gives a list of the very large number of reserved areas in India which are described as "Game Sanctuaries." His explanation of them is as follows:—"With a view to affording a certain protection to animals of this kind (the elephant, rhinoceros, ruminants, &c.), and of giving a rest to species which have been heavily thinned in a district by indiscriminate shooting in the past, or by anthrax, drought, &c., the idea of the Game Sanctuary was introduced into India (and into other parts of the world) and has been accepted in many parts of the country. The sanctuary consists of a block of country, either of forest or of grassland, &c., depending on the nature of the animal to which sanctuary is required to be given; the area has rough boundaries such as roads, fire lines, nullahs, &c., assigned to it, and no shooting of any kind is allowed in it, if it is a sanctuary pure and simple; or the shooting of carnivora may be permitted, or of these latter and of everything else save certain specified animals."

Mr. Stebbing goes on to say that sanctuaries may be formed in two ways. The area may be automatically closed and reopened for certain definite periods of years, or be closed until the head of game has become satisfactory, the shooting on the area being then regulated, and no further closing taking place, save for exceptional circumstances. The number of such sanctuary blocks, both in British India and in the Native States, will cause surprise and pleasure to most readers, and it cannot be doubted but that they will have a large effect on the preservation of wild life. The point, however, that I wish to make is that in the minds of those who have framed the Game Act, and of those who have caused the making of the sanctuaries—as indeed in the minds of their most competent critics—the dominant idea has been the husbanding of game animals, the securing for the future of sport for sportsmen. I do not forget that there is individual protection for certain animals; no elephant, except a rogue elephant, may be shot in India, and there are excellent regulations regarding birds with plumage of economic value. The fact remains that India, a country which still contains a considerable remnant of one of the richest faunas of the world, and which also is probably more efficiently under the autocratic control of a highly educated body of permanent officials, central and local, than any other country in the world, has no provision for the protection of its fauna simply as animals.

The conditions in Africa are very different from those in India. The land is portioned out amongst many Powers. The settled population is much less dense, and the hold of the white settler and the white ruler is much less complete. The possibility of effective control of native hunters and of European travellers and sportsmen is much smaller, and as there are fewer sources of revenue, the temptation to exploit the game for the immediate development of the struggling colonies is much greater. Still, the lesson of the extinction of the South African fauna is being taken to heart. I have had the opportunity of going through the regulations made for the shooting of wild animals in Africa by this country, by our autonomic colonies, by France, Germany, Italy, Portugal, and Belgium, and, with the limitation that they are directed almost solely towards the protection of animals that can be regarded as game, they afford great promise for the future. But this limitation is still stamped upon them, and even so enthusiastic a naturalist as Major Stevenson-Hamilton, the warden of the Transvaal Government Game Reserves, who has advocated the substitution of the camera for the rifle, appears to be of the opinion that the platform of the convention of 1900 is sufficient. It included the sparing of females and immature animals, the establishment of close seasons and game sanctuaries, the absolute protection of rare species, restrictions on the export for trading purposes of skins, horns, and tusks, and the prohibition of pits, snares, and game traps. Certainly the rulers of Africa are seeing to the establishment of game reserves. As for British Africa, there are two in Somaliland, two in the Sudan, two in Uganda, and two in British East Africa (with separate reserves for eland, rhinoceros, and hippopotamus), two in Nyasaland, three in the Transvaal, seven in Rhodesia, several in Natal and in Cape Colony, and at least four in Nigeria. These are now administered by competent officials, who, in addition, are usually the executive officers of the game laws outside the reserved territory. Here again, however, the preservation of game animals and of other animals of economic value, and of a few named species, is the fundamental idea. In 1909 I had the honour of being a member of a deputation to the Secretary of State for the Colonies, arranged by the Society for the Preservation of the Wild Fauna of the Empire, one of the most active and successful bodies engaged in arousing public opinion on the subject. Among the questions on which we were approaching Lord Crewe was that of changes in the locality of reserves. Sometimes it had happened that for the convenience of settlers or because of railway extension, or for some other reason, proposals were made to open or clear the whole or part of a reserve. When I suggested that the substitution of one piece of ground for another, even of equivalent area, might be satisfactory from the point of view of the preservation of large animals, but was not satisfactory from the zoological point of view, that in fact pieces of primeval land and primeval forest contained many small animals of different kinds which would be exterminated once and for all when the land was brought under cultivation, the point was obviously new not only to the Colonial Secretary, who very courteously noted it, but to my colleagues.

This brings me to the general conclusion to which I wish to direct your attention, and for which I hope to engage your sympathy. We may safely leave the preservation of game animals, or rare species if these are well known and interesting, and of animals of economic value, to the awakened responsibility and the practical sense of the governing powers, stimulated as these are by the enthusiasm of special societies. Game laws, reserves where game may recuperate, close seasons, occasional prohibition and the real supervision of licence-holders are all doing their work effectively. But there remains something else to do, something which I think should interest zoologists particularly, and on which we should lead opinion. There exist in all the great continents large tracts almost empty of resident population, which still contain vegetation almost undisturbed by the ravages of man, and which still harbour a multitude of small animals, and could afford space for the larger and better-known animals. These tracts have not yet been brought under cultivation, and are rarely traversed except by the sportsman, the explorer, and the prospector. On these there should be established, in all the characteristic faunistic areas, reservations which should not be merely temporary recuperating grounds for harassed game, but absolute sanctuaries. Under no condition should they be open to the sportsman. No gun should be fired, no animal slaughtered or captured save by the direct authority of the wardens of the sanctuaries, and for the direct advantage of the denizens of the sanctuaries, for the removal of noxious individuals, the controlling of species that were increasing beyond reason, the extirpation of diseased or unhealthy animals. The obvious examples are not the game reserves of the Old World, but the national parks of the New World and of Australasia. In the United States, for instance, there are now the Yellowstone National Park with more than two million acres, the Yosemite in California with nearly a million acres, the Grand Cañon Game Preserve with two million acres, the Mount Olympus National Monument in Washington with more than half a million acres, and the Superior Game and Forest Preserve with nearly a million acres, as well as a number of smaller reserves for special purposes, and a chain of coastal areas all round the shores for the preservation of birds. In Canada, in Alberta, there are the Rocky Mountains Park, the Yoho Park, Glacier Park, and Jasper Park, together extending to more than nine million acres, whilst in British Columbia there are smaller sanctuaries. These, so far as laws can make them, are inalienable and inviolable sanctuaries for wild animals. We ought to have similar sanctuaries in every country of the world, national parks secured for all time against all the changes and chances of the nations by international agreement. In the older and more settled countries the areas selected unfortunately must be determined by various considerations, of which faunistic value cannot be the most important. But certainly in Africa, and in large parts of Asia, it would still be possible that they should be selected in the first place for their faunistic value. The scheme for them should be drawn up by an international commission of experts in the geographical distribution of animals, and the winter and summer haunts of migratory birds should be taken into consideration. It is for zoologists to lead the way, by laying down what is required to preserve for all time the most representative and most complete series of surviving species without any reference to the extrinsic value of the animals. And it then will be the duty of the nations, jointly and severally, to arrange that the requirements laid down by the experts shall be complied with.

And now I come to the last side of my subject, that of zoological gardens, with which I have been specially connected in the last ten years. My friend M. Gustave Loisel, in his recently issued monumental "Histoire des Ménageries," has shown that in the oldest civilisations of which we have record, thousands of years before the Christian era, wild animals were kept in captivity. He is inclined to trace the origin of the custom to a kind of totemism. Amongst the ancient Egyptians, for instance, besides the bull and the serpent, baboons, hippopotami, cats, lions, wolves, ichneumons, shrews, wild goats, and wild sheep, and of lower animals, crocodiles, various fishes, and beetles were held sacred in different towns. These animals were protected, and even the involuntary killing of any of them was punished by the death of the slayer, but besides this general protection, the priests selected individuals which they recognised by infallible signs as being the divine animals, and tamed, guarded, and fed in the sacred buildings, whilst the revenues derived from certain tracts of land were set apart for their support. The Egyptians were also famous hunters, and kept and tamed various wild animals, including cheetahs, striped hyænas, leopards, and even lions, which they used in stalking their prey. The tame lions were sometimes clipped, as in ancient Assyria, and used both in the chase and in war. The rich Egyptians of Memphis had large parks in which they kept not only the domestic animals we now know, but troops of gazelles, antelopes, and cranes, which were certainly tame and were herded by keepers with wands. So also in China at least fifteen centuries before our era, wild animals were captured in the far north by the orders of the Emperor and were kept in the royal parks. A few centuries later the Emperor Wen-Wang established a zoological collection between Pekin and Nankin, his design being partly educational, as it was called the Park of Intelligence. In the valley of the Euphrates, centuries before the time of Moses, there were lists of sacred animals, and records of the keeping in captivity of apes, elephants, rhinoceroses, camels and dromedaries, gazelles and antelopes, and it may well be that the legend of the Garden of Eden is a memory of the royal menagerie of some ancient king. The Greeks, whose richest men had none of the wealth of the Egyptians or of the princes of the East, do not appear to have kept many wild animals, but the magnates of imperial Rome captured large numbers of leopards, lions, bears, elephants, antelopes, giraffes, camels, rhinoceroses and hippopotami, and ostriches and crocodiles, and kept them in captivity, partly for use in the arena, and partly as a display of the pomp and power of wealth. In later times royal persons and territorial nobles frequently kept menageries of wild animals, aviaries and aquaria, but all these have long since vanished.

Thus, although the taste for keeping wild animals in captivity dates from the remotest antiquity, all the modern collections are of comparatively recent origin, the oldest being the Imperial Menagerie of the palace of Schönbrunn, Vienna, which was founded about 1752, whilst some of the most important are only a few years old. These existing collections are of two kinds. A few are the private property of wealthy landowners, and their public importance is due partly to the opportunity they have afforded for experiments in acclimatisation on an extensive scale, and still more to the refuge they have given to the relics of decaying species. The European bison is one of the best-known cases of such preservation, but a still more extraordinary instance is that of Père David's deer, a curious and isolated type which was known only in captivity in the imperial parks of China. The last examples in China were killed in the Boxer war, and the species would be absolutely extinct but for the small herd maintained by the Duke of Bedford at Woburn Abbey. In 1909 this herd consisted of only twenty-eight individuals; it now numbers sixty-seven. The second and best-known types of collections of living animals are in the public zoological gardens and parks maintained by societies, private companies, States and municipalities. There are now more than a hundred of these in existence, of which twenty-eight are in the United States, twenty in the German Empire, five in England, one in Ireland, and none in Scotland. But perhaps I may be allowed to say how much I hope that the efforts of the Zoological Society of Scotland will be successful, and that before many months are over there will be a zoological park in the capital of Scotland. There is no reason of situation or of climate which can be urged against it. The smoke and fog of London are much more baleful to animals than the east winds of Edinburgh. The gardens of North Germany and the excellent institution at Copenhagen have to endure winters much more severe than those of lowland Scotland, whilst the arctic winter and tropical summer of New York form a peculiarly unfortunate combination, and none the less the Bronx Park at New York is one of the most delightful menageries in existence. The Zoological Society of Scotland will have the great advantage of beginning where other institutions have left off; it will be able to profit by the experience and avoid the mistakes of others. The Zoological Society of London would welcome the establishment of a menagerie in Scotland, for scientific and practical reasons. As I am speaking in Scotland, I may mention two of the practical reasons. The first is that in Great Britain we labour under a serious disadvantage as compared with Germany with regard to the importation of rare animals. When a dealer in the tropics has rare animals to dispose of, he must send them to the best market, for dealing in wild animals is a risky branch of commerce. If he send them to this country, there are very few possible buyers, and it often happens that he is unable to find a purchaser. If he send them to Germany, one or other of the twenty gardens is almost certain to absorb them, and, failing Germany, Belgium and Holland are near at hand. Were there twenty prosperous zoological gardens in Great Britain, they could be better stocked, at cheaper rates, than those we have now. The second practical reason is that it is a great advantage to menageries to have easy opportunities of lending and exchanging animals; for it often happens that as a result of successful breeding or of gifts on one hand, or of deaths on the other, a particular institution is overstocked with one species or deficient in another.

One of the ideas strongly in the minds of those who founded the earlier of modern zoological gardens was the introduction and acclimatisation of exotic animals that might have an economic value. It is curious how completely this idea has been abandoned and how infertile it has proved. The living world would seem to offer an almost unlimited range of creatures which might be turned to the profit of man and as domesticated animals supply some of his wants. And yet I do not know of any important addition to domesticated animals since the remotest antiquity. A few birds for the coverts, fancy water-fowl for ponds and lakes, and brightly plumaged birds for cages or for aviaries have been introduced, chiefly through zoological societies, but we must seek other reasons for their existence than these exiguous gains.

Menageries are useful in the first place as educational institutions, in the widest sense of the word. Every new generation should have an opportunity of seeing the wonder and variety of animated nature, and of learning something that they cannot acquire from books or pictures or lectures about the chief types of wild animals. For that reason zoological gardens should be associated in some form with elementary and secondary education. We in London admit the children from elementary schools on five mornings in the week at the nominal charge of a penny for each child, and in co-operation with the Educational Committee of the London County Council, we conduct courses of lectures and demonstrations for the teachers, who will afterwards bring their children to visit the gardens.

Menageries provide one of the best schools for students of art, for nowhere else than amongst living animals are to be found such strange fantasies of colour, such play of light on contour and surface, such intricate and beautiful harmonies of function and structure. To encourage art the London society allows students of recognised schools of drawing and painting, modelling and designing, to use the gardens at nominal rates.

Menageries provide a rich material for the anatomist, histologist, physiologist, parasitologist, and pathologist. It is surprising to note how many of the animals used by Lamarck and Cuvier, Johannes Müller and Wiedersheim, Owen and Huxley, were obtained from zoological gardens. At all the more important gardens increasing use is being made of the material for the older purposes of anatomical research and for the newer purposes of pathology and physiology.

There remains the fundamental reason for the existence of menageries, that they are collections of living animals, and therefore an essential material for the study of zoology. Systematic zoology, comparative anatomy, and even morphology, the latter the most fascinating of all the attempts of the human intellect to recreate nature within the categories of the human mind, have their reason and their justification in the existence of living animals under conditions in which we can observe them. And this leads me to a remark which ought to be a truism, but which, unfortunately, is still far from being a truism. The essential difference between a zoological museum and a menagerie is that in the latter the animals are alive. The former takes its value from its completeness, from the number of rare species of which it has examples, and from the extent to which its collections are properly classified and arranged. The value of a menagerie is not its zoological completeness, not the number of rare animals that at any moment it may contain, not even the extent to which it is duly labelled and systematically arranged, but the success with which it displays its inhabitants as living creatures under conditions in which they can exercise at least some of their vital activities.

The old ideal of a long series of dens or cages in which representatives of kindred species could mope opposite their labels is surely but slowly disappearing. It is a museum arrangement, and not an arrangement for living animals. The old ideal by which the energy and the funds of a menagerie were devoted in the first place to obtaining species "new to the collection" or "new to science" is surely but slowly disappearing. It is the instinct of a collector, the craving of a systematist, but is misplaced in those who have the charge of living animals. Certainly we like to have many species, to have rare species, and even to have new species represented in our menageries. But what we are learning to like most of all is to have the examples of the species we possess, whether these be new or old, housed in such a way that they can live long, and live happily, and live under conditions in which their natural habits, instincts, movements, and routine of life can be studied by the naturalist and enjoyed by the lover of animals.

Slowly the new conditions are creeping in, most slowly in the older institutions hampered by lack of space, cumbered with old and costly buildings, oppressed by the habits of long years and the traditions established by men who none the less are justly famous in the history of zoological science. Space, open air, scrupulous attention to hygiene and diet, the provision of some attempt at natural environment are receiving attention that they have never received before. You will see the signs of the change in Washington and New York, in London and Berlin, in Antwerp and Rotterdam, and in all the gardens of Germany. It was begun simultaneously, or at least independently, in many places and under the inspiration of many men. It is, I think, part of a general process in which civilised man is replacing the old hard curiosity about nature by an attempt at sympathetic comprehension. We no longer think of ourselves as alien from the rest of nature, using our lordship over it for our own advantage; we recognise ourselves as part of nature, and by acknowledging our kinship we are on the surest road to an intelligent mastery. But I must mention one name, that of Carl Hagenbeck, of Hamburg, to be held in high honour by all zoologists and naturalists, although he was not the pioneer, for the open-air treatment and rational display of wild animals in captivity were being begun in many parts of the world while the Thier-Park at Stellingen was still a suburban waste. He has brought a reckless enthusiasm, a vast practical knowledge, and a sympathetic imagination to bear on the treatment of living animals, and it would be equally ungenerous and foolish to fail to recognise the widespread and beneficent influence of his example.

However we improve the older menageries and however numerous and well-arranged the new menageries may be, they must always fall short of the conditions of nature, and here I find another reason for the making of zoological sanctuaries throughout the world. If these be devised for the preservation of animals, not merely for the recuperation of game, if they be kept sacred from gun or rifle, they will become the real zoological gardens of the future, in which our children and our children's children will have the opportunity of studying wild animals under natural conditions. I myself have so great a belief in the capacity of wild animals for learning to have confidence in man, or rather for losing the fear of him that they have been forced to acquire, that I think that man, innocent of the intent to kill, will be able to penetrate fearlessly into the sanctuaries, with camera and notebook and field-glass. In any event, all that the guardians of the future will have to do will be to reverse the conditions of our existing menageries and to provide secure enclosures for the visitors instead of for the animals.

I must end as I began this address, by pleading the urgency of the questions I have been submitting to you as an excuse for diverting your attention to a branch of zoology which is alien from the ordinary avocations of most zoologists, but which none the less is entitled to their fullest support. Again let me say to you that I do not wish to appeal to sentiment; I am of the old school, and, believing that animals are subject and inferior to man, I set no limits to human usufruct of the animal kingdom. But we are zoologists here, and zoology is the science of the living thing. We must use all avenues to knowledge of life, studying the range of form in systematic museums, form itself in laboratories, and the living animal in sanctuaries and menageries. And we must keep all avenues to knowledge open for our successors, as we cannot guess what questions they may have to put to nature.

SECTION E.

GEOGRAPHY.

From the Opening Address by Colonel Sir C. M. Watson, K.C.M.G., C.B., President of the Section.

Leaving the Sudan,[1] I would like to allude to a very important geographical undertaking which has made considerable progress during the past year. This is the production of the international map of the world on the scale of 1/1000000, a project which has been under the consideration of the leading geographers of the important countries for more than twenty years, since it was first proposed at the International Geographical Congress held at Berne in 1891. The question was discussed at succeeding geographical congresses, but did not take definite shape until the meeting held at Geneva in 1908, when a series of resolutions dealing with the subject were drawn up by a committee composed of distinguished men of many nations, which was appointed to formulate rules for the production of the maps, so as to ensure that they should be prepared upon a uniform system.

These resolutions were approved at a general meeting of the Geneva Congress, and were forwarded by the Swiss Government to the British Government for consideration, whereupon the latter issued invitations to the Governments of Austria-Hungary, France, Germany, Japan, Russia, Italy, Spain, and the United States of North America, asking them to nominate delegates to act as the members of an international committee to meet in London and debate the question. The committee assembled at the Foreign Office in November, 1909, and Colonel S. C. N. Grant, C.M.G., then Director-General of the British Ordnance Survey, was appointed president. The proceedings were opened by the Under-Secretary of State for Foreign Affairs, Sir Charles Hardinge, G.C.M.G., now Lord Hardinge, who, in his address, referred to the progress that had already been made with regard to the international map, and expressed the hope, on behalf of the British Government, that the great undertaking might be brought to a satisfactory conclusion.

The main business before the committee was to settle on the mode of execution of the map, especially as regards the size of the sheets, so as to ensure that adjacent sheets, published by different countries, should fit together; and also to settle upon the symbols, printing, and conventional signs to be used, in order that these should be uniform throughout. A series of resolutions, embodying the decisions arrived at concerning these various points, was approved and drawn up in English, French, and German, the first of these languages being taken as the authoritative text. As the map was to embrace the whole surface of the globe, the method of projection to be adopted was, of course, a very important consideration, and, after due deliberation, it was decided that a modified polyconic projection, with the meridians shown as straight lines, and with each sheet plotted independently on its central meridian, would prove the most satisfactory.

The surface of the sphere was divided into zones, each containing four degrees of latitude, commencing at the equator, and extending to 88° North and 88° South latitude. There were thus twenty-four zones on each side of the equator, and these were distinguished by the letters A to V north, and A to V south. This fixed the height of each sheet. For the width of the sheets, the surface of the sphere was divided into sixty segments, each containing six degrees of longitude, and numbered consecutively from one to sixty, commencing at longitude 180°. This arrangement made each sheet contain six degrees of longitude by four degrees of latitude; but, as the width of the sheets diminished as they approached the poles, it was decided that, beyond 60° North, or 60° South, two or more sheets could be combined. Each sheet could thus be given a clear identification number defining its position on the surface of the globe, without it being necessary to mention the country included in it, or the latitude and longitude. For example, the sheet containing the central part of England is called North, N 30.

In order to ensure that the execution of all the maps should be identical, a scheme of lettering and of conventional topographical signs was drawn up and attached to the resolutions; and it was decided that a scale of kilometres should be shown on each sheet, and also a scale of the national measure of length of the country concerned. As regards the representa-

[1] The main part of the address dealt with the geography of the Sudan and some important points in its history.

tions of altitude it was arranged that contours should be shown at vertical intervals of a hundred metres, or at smaller intervals in the case of very flat, and larger in the case of steep ground, the height being measured from mean sea-level, as determined in the case of each country; while the levels of the surface of the country were to be indicated by a scale of colour tints, the colours being green from 0 to 300 metres, brown from 300 to 2500 metres, and purple above 2500 metres. In the same manner the depths of the ocean and of large lakes were to be indicated by varying tints of blue, so as to show intervals of 100 metres. In order to ensure uniformity in the scale of colours to be used, a copy of it, as approved by the committee, was included in the plate of topographical symbols.

The whole scheme was thoroughly well worked out, and great credit is due to the members of the international committee for the manner in which they carried out their difficult task. Since the meeting of the committee in 1909 the preparation of the sheets, in accordance with the principles decided upon, has been taken in hand in several countries, and a number of these have been issued, which give a good idea of what this great map, the largest ever contemplated, will be like. These sheets deserve to be carefully studied, and will doubtless be the subject of considerable criticism, as there are several points which seem worthy of examination.

In the first place, it is for consideration whether it would not have been better if the colour scheme for representing differences of altitude had been omitted, as it is doubtful whether the advantage of the result gained is commensurate with the increased cost of printing the colours. And one naturally asks for what purpose is the map intended. Is it for the use of skilled geographers, of whom there are a comparatively small number in each country, or is it for the instruction of ordinary people? If it is for the latter, it is to be feared that the colour scheme will give rise to erroneous impressions. Compare, for example, sheet North, M 31, of France, with sheet South, H 34, of part of South Africa. In the former, as the greater part of the country shown is less than 300 metres above the sea, the general colour of the sheet is green, while in the latter, as nearly the whole of the country included has an altitude of more than 300 metres, the map is for the most part brown. This to the less educated man will probably convey the idea that, while France is a fertile country, South Africa is a desert. The fact, too, that the darker tint of green represents the lower level and the lighter the higher, while, in the case of the brown, the lighter represents the lower and the darker the higher, and, in the case of the purple, the relative strength of the tints is again reversed, is rather confusing.

There is another point as regards the colour scheme which might be noticed, that is, that it is not the same on different sheets. For example, the scale of tints adopted in sheet North, O 30 (Scotland), North, M 31 (France), and North, K 35 (Turkey), do not correspond. In the Scotch map the brown colour commences at an altitude of 200 metres, in the French at 300 metres, and in the Turkish at 400 metres. There may be some reason for this, but it appears not to be in accord with the resolutions of the committee. Another reason for omitting the colour scheme for altitudes is that it might be better to keep colour work for other purposes, such as indicating political divisions, as there can be little doubt that so good a map as this, when completed, will be largely used for many purposes. It might be better that on a map of this small scale only the horizontal features, such as coast lines, river courses, railways, roads, and the position of towns should be shown, while to represent height graphically tends to obscure the former.

Another criticism I would venture to make is that the resolutions of the committee appear to have been drawn up on the supposition that the whole world has been accurately surveyed, and no attempt seems to have been made to distinguish between those regions of which the maps are based on triangulation, such as England and parts of Europe, and the countries of which complete surveys have not yet been made. As the construction of the map proceeds and sheets are prepared of parts of the world our knowledge of which is imperfect, this want will become more pressing, but it is noticeable even with regard to the sheets already published. It is one of the evils of cartography that where anything is shown on a carefully engraved map it comes to be regarded as true, and, if it afterwards turns out to be erroneous, it is not easy to get it altered.

The scale of the map, 1/1000000, appears to have been wisely chosen, as it is sufficiently large to give an adequate amount of detail, while, at the same time, the sheets will not be unduly numerous. Of course, for an international map a cadastral scale was essential, although for national maps a scale based upon the national system of measures is more convenient, as, for example, in the United Kingdom, where the scale of one inch and six inches to the mile are better than scales of 1/50000 and 1/10000 would have been. They are more suited for the majority of individuals, and an ordinary foot-rule can be used for measuring distances, instead of having to take them off with a pair of dividers from the printed scale on the map.

Looked at from the general point of view, there can be no doubt that the international map is a most important and valuable undertaking. It is satisfactory that such a leading part in the matter has been taken by the British officers of the Royal Engineers and by the Royal Geographical Society.

In speaking of this map, I have referred to the advisability, if not the necessity, of distinguishing between what is accurately and what is inaccurately known, and this brings me to another matter of considerable interest, the preparation of maps based upon the observations and information collected by explorers in unknown or little known countries. To these explorers, some of whom have not been trained in geographical science, a large amount of detail shown upon modern maps is due, and it is only a small proportion of the land surface of the globe that has, up to the present, been surveyed in a scientific manner.

It is therefore of the greatest importance that the best value possible should be obtained from the work done by explorers, and this in the past has not always been sufficiently attended to, though during the last few years it is better understood. The people who stop at home in comfortable ease do not sufficiently realise the difficulties under which the conscientious traveller works and gathers together information about the country he passes through. Formerly, he generally had to work out his own observations and compile his own maps, but now conditions in this respect have greatly improved, and when he brings home his observations, notes, and sketches he can hand them over to some body, such as the Royal Geographical Society, by whom they will be put in shape in a better manner than he could do it for himself. One has heard of an explorer in a little-known country sitting up all night after a hard day's work, working out his astronomical observations, and trying to put his rough surveys into shape. He would have done better to have gone to sleep and prepared himself by a good rest for the next day's journey. In fact, it would be better if an explorer never looked at the figures of an observation after he had recorded them, or read over the notes of his past work, confining himself to recording what he has actually seen day by day as accurately as circumstances permitted, and carefully distinguishing what he really saw from what he thought he had seen, or what he had heard.

It would be easy to adduce instances of the errors which have arisen from the neglect of such precautions. Perhaps one of the best known is that I have already alluded to, when James Bruce, a careful explorer, because he had made up his mind that the Blue Nile was the real Nile, passed the White Nile without taking the trouble to examine it, and recorded it as being a comparatively insignificant river. Then there was the case of Sir Samuel Baker, who, having reached the shores of the Albert Nyanza with great difficulty, depended too much on what he was told by the natives, and showed it on his map as extending many miles to the south of the equator. But great responsibility rests also upon those who have the task of compiling a map from the notes of an explorer, and the greatest care has to be taken to show only what is really known, and not what is uncertain. Geographers, whether in the field or in the drawing office, should always hold up before themselves a standard of accuracy higher than it is always easy to live up to.

Geography under its more ancient name of geometry is, of course, the mother of all sciences, although at the present time geometry has got a more narrow meaning, and is perhaps regarded by some as independent of geography, although really only a branch of it. The study of the earth upon which they lived was, to the ancient nations, the most important of all studies, and it is interesting to trace how astronomy, mathematics, geology, and ethnology are all so interspersed with geography that it is difficut to separate them. It is satisfactory to note how from the very first the British Association has always recognised the great importance of geography, since the first meeting of the Association at Oxford in 1832, when Sir Roderick Murchison, so well known to fame, acted as president of the Geographical and Geological Section. These two sciences remained united in the same section until the meeting at Edinburgh in 1850, when Sir R. Murchison was again the president. But, at the next meeting at Ipswich in 1851, they were separated, and while geology remained as the subject of Section C, geography, on account of its great importance, was made the subject of Section E, and the science of ethnology was united with it. Sir R. Murchison was the first president of the new Geographical Section, and was afterwards president no fewer than six times of Section E, showing the great importance attached by him to the study of the science of geography. May I express the hope that the presidents of the section will endeavour in future to follow, however humbly, in the footsteps of that leader of science.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY PROF. ARCHIBALD BARR, D.Sc., PRESIDENT OF THE SECTION.

ONE of the great engineers of the past, Leonardo da Vinci, prefaced a collection of observations on various themes, including the mechanical arts, with the remark:—"Seeing that I cannot choose any subject of great utility or pleasure, because my predecessors have already taken as their own all useful and necessary themes, I will do like one who, because of his poverty, is the last to arrive at the fair, and not being able otherwise to provide himself, chooses all the things that others have already looked over and not taken, but refused as being of little value. With these despised and rejected wares—the leavings of many buyers—I will load my modest pack, and therewith take my course." These words describe, with some approach to exactitude, the position in which I find myself, and may form a fitting introduction to an address that will be discursive rather than systematic, and perhaps more critical than constructive.

It may be less true to-day than it was four hundred years ago to say that all important matters concerning the existing state of the mechanical arts have been dealt with in spoken or written addresses. Each year there might be found sufficient subject-matter for a general survey of the ground that has been covered or a sketch of what lies before us. But each important advance is nowadays recorded as soon as it is made, and I do not feel that I have any special call to assume the *rôle* of the historian, nor can I claim any right to don the mantle of the prophet.

A president of this section who is not disposed to deal with the general aspects of the progress being made in the department of science allotted to us can usually find a large enough subject for his address within the limits of that part of our wide field with which his own work has been more particularly identified, and it might be expected that I would devote my address to a discussion of the conclusions at which I have arrived during thirty-six years of practice and experience in the teaching of mechanical science. But so much has been said of late on the training of engineers, and so many divergent and even irreconcilable opinions have been expressed regarding the lines such training should follow, that I feel sure I shall be relieving the apprehensions of some of my audience if I begin by stating that I do not propose to inflict upon you a discourse on that threadbare theme. There are limits to the endurance even of those who practise a profession well calculated to inculcate the virtues of patience and forbearance.

When we have as president of the section one who has broken new paths in the exploration of the territory assigned to us, or to whose labours the fruitfulness of some corner of the domain may be chiefly attributed, we would scarcely be disposed to tolerate the omission from his address of an account of his own special work, in investigation or in practice, and the developments to which it is leading. But while, no doubt, every worker is the chief authority on something or other, the plot he cultivates may be so restricted in area, and its products may bulk so little in the general harvest, as to form no suitable topic to engage the attention of his fellow-workers on such an occasion as this.

When an engineer leaves practice in the great, and takes to the devising and production of what are usually referred to specifically as "scientific instruments" (though all machines and mechanical appliances may properly be classed as such), his colleagues in the profession may be disposed to look upon the change as a degeneration of species. Naturally I am not disposed to accept such a verdict. Remembering the careers of those who did most in the founding of the various branches of present-day practice, I am quite prepared to accept as applicable another phase borrowed from the language of the biologist, and to let it be called a "reversion to a more primitive type." But instead of dealing with the narrow branch of applied science with which my own practice is chiefly connected, I prefer to utilise the short time at my disposal to make some observations upon a larger and more general theme. The thesis which I propose to uphold may not fall very obviously within the scope of the original aims of the British Association, but it has, at least, an intimate bearing on the work of those who are concerned with the applications of mechanical science.

Tredgold's oft-quoted definition of engineering as "the art of directing the great sources of power in nature for the use and convenience of man" may well be taken, and often has been taken, as a text upon which to hang a discourse on the importance of the profession to which many of us belong, the leading part it has played in the process of civilisation, and the dependence of the world to-day on its activities. But the words suggest failures as well as achievements, and responsibilities no less than privileges. The definition suggests that the engineer not only fails in his vocation if he does not accomplish something for the use and convenience of man, but further, that he acts contrary to the spirit of his profession if he directs the sources of power in nature to the unuse[1] or inconvenience of man; and surely we must understand by "man" not the engineer's immediate client but mankind in general. The works of the engineer are to be used by some people; they have to be endured by all.

Taking the highest view of our calling—and surely we do not hold that ours is in any sense a sordid or selfish vocation—the engineer fails in the fulfilment of his duty in so far as his works are detrimental to the health or destructive to the property of the community, or in so far as they are unnecessarily offensive to any of the senses of those who are compelled to live with them. There has been too great a neglect of such considerations. The medical practitioner is held to be negligent of his duty if he acts solely in the immediate interests of his patient, and does not take due precaution to guard against the spread of disease or the offence of the community by the exhibition of unsightly forms. We should take as high a view of our responsibilities.

In his presidential address to the Association last year, Sir Wm. Ramsay said that the question for the engineer has come to be not "can it be done?" but "will it pay to do it?" The answer to this question, in respect to any particular proposal, depends on the width of view we take in answering two preliminary questions: whose interests are we to consider? and, what do we mean by paying? Of course, there are limits that must be set in answering each of these; my present contention is that these limits are usually much too narrowly drawn. A road surveyor may save a few pence or shillings to his county council by leaving a piece of newly metalled road unrolled—because the clock strikes the hour for retiring—and may thereby cause expense, amounting to pounds, it may be to hundreds of pounds, through damage to motor-cars or the laming of horses (not to speak of loss of life or limb), to the users of the road, who are, after all, the clientèle he is there to serve. Does it pay? The authorities of a city will spend large sums on the adornment of the streets with stately and ornate buildings, and on the purchase of works of art—and rightly so, though comparatively few of the citizens can appreciate or even give themselves the chance of appreciating them—while they will tolerate or even be directly responsible for the running on these same streets of quite unnecessarily ugly and noisy tramcars, and congratulate themselves on the drawing of a paltry income from the display of hideous advertisements that are constantly before the eyes of the whole community. Does it pay thus to separate æsthetic from utilitarian demands and interests?

It is too much to assume that engineers could meet all the reasonable demands of their immediate clients without producing, at least temporarily, secondary effects that may be of inconvenience to some members of the community. Bacon, indeed, said that "The introduction of new Inventions seemeth to be the very chief of all human actions. Inventions make all men happy without either Injury or Damage to any one single Person." But Bacon was a philosopher, and dealt with ideals rather than with hard facts, and in his times inventors had not yet begun to dominate all the elements of our physical environment. Had he lived to-day beside one of our country roads he might have had something to say, in another key, regarding motor-cars and dust; or had his lot been cast in the proximity of a great centre of industry he might have modified his conviction of the universality of the benefits conferred by the inventor. He might even have been disposed to agree with a literary man of to-day who is reported as asserting that "The universal and blatant intrusion of Science into our lives has resulted in a total disappearance of repose." Isolated and unqualified statements such as those I have quoted are like proverbs—you can always find two that are directly opposed. The truth lies about midway between these extremes, or rather there are aspects of the facts in regard to which one is an approach to the truth, and aspects in which the other has some justification. Our aim should be to make Bacon's dictum have more of truth and Mr. Stephen Coleridge's assertion have less foundation in fact. And the outlook seems to me to be a very hopeful one, though to be able to take an altogether favourable view of the tendencies of the present time, one must be an optimist of the true order—"One who can scent the harvest while the snow is on the ground."

When we examine into the immediate causes of the injuries and inconveniences that result from our activities we find that they are due in all, or almost all, cases to failures rather than to successes. The more completely the engineer achieves the primary end of his work the less is the damage or injury that can be laid to his charge. If it can be shown that this is a very general law, as I think it can be, we may look forward to the elimination, as a direct result of progress in the mechanical arts, of the nuisances and inconveniences for which, in some measure at least, we must accept responsibility. And not only so, but the converse will be equally true—the more we keep in view the removal or avoidance of anything that can cause offence, the more rapidly we shall advance in the attainment of the primary ends at which we aim. Consider, by way of example, the nuisance to which I have referred, and of which we hear so much—the raising of dust by motor-cars. I shall not discuss the debated question as to how far the motor-car produces dust, or only distributes it, nor shall I deal in detail with the possible remedies. We hope to have a paper on the subject at this meeting from one of our leading authorities. For my present purpose it suffices to point out that it is no part of the function of a road surface to fritter itself down into dust under traffic of any kind. The ideal road would be one that would not wear at all, and the nearer we approach this ideal of a permanent road surface, the less will be the inconvenience caused, not only to those responsible for the upkeep of the road, but to the general public. And conversely, the more attention we give to the devising of a dustless road the more rapid will be our advance towards the provision of one best suited for all the purposes which a road is intended to serve. We had dusty roads

1 We have no word to denote very clearly the negative of *use*, as the term here applied: *unuse* may serve for the present.

before the motor-car came into being, but the demand that is being forced upon the engineer to eliminate this nuisance is leading to an improvement of our roads for all users. The inventors of the automobile will yet merit the thanks even of those who, bemoaning the blatant intrusion of science into our lives, may discard the railway train and the motor-car and take to the stage-coach of their grandfathers with a view to the recovery of some of the lost repose.

Again, the combustion of fuel does little harm to anyone; it is the imperfection of the combustion that is the main cause, almost the sole cause, of injury to health, to property, and to the amenity of populous centres. Of course, one knows that smokeless combustion is not necessarily, nor always, the most economical, but that is only because we have not yet learned how to use fuel in anything like a perfect manner. But all the tendencies at the present time are towards improvement, and the more attention we pay to the elimination of the smoke nuisance the more rapid will be our progress in the economical use of one of the most valuable of our inheritances. It is therefore clearly the duty of every engineer who has to do with power or heat production—for the credit of his profession and even in the interests of his immediate clients—to consider the use and convenience of all who can be affected by the work for which he is responsible. The time is not far distant when the direct burning of bituminous coal in open grates will be looked upon as not only a source of serious harm but as a culpably wasteful practice. Great progress has been made in processes for the partial distillation of coal by which a free-burning and quite smokeless fuel is prepared and valuable by-products (so-called) are conserved. If all engineers concerned with the design and application of plants in which coal is used had a due sense of their responsibilities to the community, progress would have been, and would to-day be, much more rapid; and economies would be effected that would, in themselves, amply justify the application of more scientific methods of utilising the constituents of a very complex material, which we are too apt to look upon as merely a convenient source of heat—plentiful enough and cheap enough, as yet, to be used in a most wasteful manner. It will not be to the credit of our profession if it should require restrictive legislation not only to prevent a gross interference with the health and comfort of the community and the amenities of our centres of industry or of population, but to effect economies in the utilisation of the chief of the sources of power which it is our function to direct to the best advantage of all concerned.

In other directions also we see that progress towards economy is leading to a reduction, and possibly to the entire elimination, of all the nuisances associated with the older methods of power and heat production. The great improvements that have recently been made in producer plants and gas engines have rendered out of date, as regards economy, at least the smaller sizes of steam plants which are so fruitful a source of injury and inconvenience to the community; and we now have engines of the Diesel, and the so-called semi-Diesel, types that can utilise natural oils, and oils obtained in the distillation or partial distillation of coal, not only with an efficiency hitherto unattained in heat-engines, but "without injury or damage to any one single person"—except possibly the maker of inferior[2] plants.

Present indications point to the coming of a time, in the near future, when the power and heat required for industrial and domestic purposes will be distributed electrically, in a perfectly inoffensive manner, from large central stations; and even at these stations there will be no pollution of the atmosphere that could give the most sensitive of critics any just grounds of complaint against the intrusion of science into our lives. In his presidential address to the Institution of Electrical Engineers in November, 1910, Mr. Ferranti dealt in a most masterly way with this, which is undoubtedly the greatest of the many schemes at present before the engineering profession. That address reads like a chapter from a romance of Utopia, but unlike most of the forecasts that have been presented to us of ideal conditions in a world of the future, the system which Mr. Ferranti sketches out, and advocates with so much knowledge and convincing argument, does not depend for its reasonableness on the postulation of a perfected humanity. It would not only provide vastly improved conditions of life for the community as a whole, but it would satisfy the more selfish aims of the users of power and the makers of machinery, by increasing the economy of production and stimulating the demand for mechanical appliances. No doubt there may be some who will hold that to commend any worthy scheme, to those who might carry it out, by an appeal to their selfish interests is an altogether immoral kind of argument. I do not think so. Advancement of the race through benefits to the individual is, at least, not inconsistent with nature's method of securing progress. However much we may desire to develop a purely altruistic spirit in men of all classes, we must meantime make the best of human nature as it is, and recognise that the rapidity of our progress toward better conditions of life will be in proportion to the advantages that each advance can promise to those who would be immediately concerned in its realisation.

It is just a hundred years since passengers were first carried on the Clyde in a mechanically-propelled ship, and to-day—when they are not too completely obscured by smoke—we can see the successors of the *Comet* plying on that river with power plants of greatly superior overall efficiency but showing little advance in regard to the combustion of the fuel. Had the emission of smoke from river craft been prohibited years ago, there is little doubt that engineers would have let few days pass without arriving at some solution of the problem of inoffensive power production, and the demand for economy would have looked after itself. How much better it would be were engineers to take the wider view of their duties and responsibilities to which I have referred, and realise that they are acting contrary to the true spirit of their profession when they produce appliances that pollute the atmosphere for miles around to the hurt and inconvenience of those whose "use" they are intended to serve. But this year a ship has left the Clyde that we hope may be the forerunner of a new race which will attain a higher efficiency than any of the direct descendants of the *Comet*, and that will ply their trade without inconvenience to man or beast, who can claim some right to be permitted to enjoy an unpolluted atmosphere and the measure of sunshine which nature—sparingly enough in those regions—intended to provide.

But there are injuries which we may inflict upon the community other than those to health and physical comfort. Everyone, even the least cultured, has some sense of the beautiful and the comely, and is affected by the aspects of his environment more than he himself can realise. The engineer, then, whose works needlessly offend even the most fastidious taste is acting contrary to the spirit of his profession, at its best.

[2] My typist in transcribing a rather illegible draft of this passage substituted for the adjective I have here used the less restrained, but perhaps equally appropriate one, "infernal," but I noticed this in time to amend the emendation. I had no intention to speak so candidly of any of the works of members of my own profession.

There has been far too great a disregard of æsthetic considerations in the everyday work of the engineer—we usually take a too exclusively utilitarian view of our calling. We should not be prepared to accept, as referring to the arts we practise at their best, the distinction drawn by a philosophical writer between "the *mechanical* arts which can be efficiently exercised by mere trained habit, rote, or calculation," and "the fine arts which have to be exercised by a higher order of powers."[3] And I think it can be shown that a greater regard for artistic merit in our designs would not necessarily lead to extravagance, but, in many cases, would conduce to economy and efficiency. It is at least true—and much less than the whole truth—that greater artistic merit than is commonly found in our works could be attained with no sacrifice of structural fitness, or of suitability for the purposes they are designed to serve.

There was a time when engineers made desperate attempts to secure artistic effects by the embellishment (?) of their productions with features which they believed to be ornamental. Fortunately the standard of taste has risen above and beyond this practice in the case of most members of our profession and most of our clients. We are all familiar with illustrations of philosophical instruments, and other mechanical contrivances, of the early times, that vied in lavishness of adornment—though not in artistic merit—with those wonderful astronomical appliances that were carried—as trophies of war!—from Pekin to Sans Souci. Many of us can remember a time when the practice had not altogether disappeared, even in the design of steam engines, lathes, and other products of the mechanical engineer's workshop. I well remember in my apprenticeship days the building of a beam engine that was a triumph of ingenuity in the misapplication of decorative features. In place of the mildly ornamented pillars and entablature of Watt's design, there was provided, for the support of the journals of the beam, a pair of A frames constructed in the form of elaborately moulded Gothic arches flanked by lesser arches on each side, while the beam itself, and many other parts, were plentifully provided with even less appropriate embellishments borrowed from the art of the stonemason. It is some consolation to remember that the clients for whom the engine was built were not of this country, and that the design itself was not a product of the workshop that was favoured with the contract to produce this amazing piece of cast-iron architecture. We have all seen wrought-iron bridges the inattractive features of which were concealed by cast-iron masks—in the form of panelling, or of sham pillars and arches with no visible means of support—that not only have no connection with the structural scheme, but suggest types of construction that could not, by any possibility, meet the requirements. Structures of this kind remind one of the pudding which the White Knight (with good reason when we remember the characteristics of his genius) considered the cleverest of his many inventions. It began, he explained, with blotting-paper, and when Alice ventured to express the opinion that that would not be very nice, he assured her that though it might not be very nice *alone* she had no idea what a difference it made mixing it with other things—such as gunpowder and sealing-wax.

There are, and must always be, wide differences of opinion regarding what is good or bad in matters of taste, but we may go so far in generalisation as to say that we can admire the association of elements we *know* to be incongruous only in compositions that are intended to be humorous. "All human excellence has its basis in reason and propriety; and the mind, to be interested to any efficient purpose, must neither be distracted nor confused."[4] But to be able to judge of the propriety or reasonableness of any composition we must have some knowledge of the essential qualities and relationships of its component parts, and excellence cannot depend upon an appeal to ignorance. We can quite imagine that the White Knight's pudding would appeal as an admirable and most ingenious concoction to one who lacked a knowledge of the dietetic value of blotting-paper and was willing to take for granted the excellence of gunpowder as a spice and of sealing-wax as a flavouring. No artist would be bold enough to include a polar bear or a walrus in the composition of a picture of the African desert, nor be prepared to consider as a legitimate exercise of the artistic imagination the depicting an Arab and his camel wending their weary way across the Arctic snows. He would recognise the incongruity, and might even realise that it is only a lack of imagination or of true inventive power that could lead anyone to resort to such measures for the securing of a desired colour scheme. These are lengths to which even artists will not go in the arrangement of elements in a composition. But an artist *will* secure a colour scheme at which he aims by the introduction into his landscape of a rainbow in an impossible position, or of impossible form or dimensions, or with colours arranged according to his own fancy, though in this there is a much more essential unreasonableness. A polar bear might be transported to the desert, and an Arab might conceivably find his way to the regions of snow and ice, but a rainbow cannot wander from the place assigned to it by nature, nor can it have other than the ordained form or dimensions or sequence of colours. No artist would paint a figure holding a candle and make the light fall on the side of the face remote from the source, but he will, and usually does, paint the moon illuminated on the side remote from the sun. Why? Simply because he has not before his mind the essential absurdity of the scheme, if indeed he knows why the moon shines. Artists who deal with nature in any of its aspects may be commended to "mark, learn, and inwardly digest" Whistler's definition of their calling: "Nature contains the elements in colour and form of all pictures . . . but the artist is born to pick and choose, and group with science, these elements, that the result may be beautiful." Whether or not we are to understand that Whistler intended to include an accurate knowledge of physical facts and phenomena in what he calls *science*, he cannot have meant anything less than *sense*.

So in regard to the arts of construction, we may say that mechanical science provides the elements of all structures, and the craftsman—be he called engineer or architect—is born to pick and choose, and group with science, these elements, that the result may be useful—and not devoid of grace.

The only valid excuse for such departures from the fit and rational in painting or in structural design as those which I have instanced is ignorance on the part of the designer of the nature of the elements he employs, or a lack of skill to devise a possible or reasonable arrangement of details that will secure the general effect he desires.

It may almost savour of sacrilege to quote, in this connection, from the writings of that "Wild, wilful, fancy's child" the story of whose eight short years of life and literary work Dr. John Brown has given in his charming "Pet Marjorie"—a record of perhaps the shortest human life that has formed the subject of a biography. But the lines are too pertinent to my purpose to be withheld, and the frankness of the

[3] Enc. Brit., eleventh edition, article "Art."

[4] Mr. Duppa's "Life of Michelangelo."

confessions they contain, of a childlike limitation of artistic power, may be commended to those who practise either the fine arts or the arts of construction, and feel compelled to "trust to their imagination for their facts," or to resort to the association of incompatible details for lack of knowledge, or of ability to attain their ends by more reasonable means.

Marjorie writes of the death of James II.:—

"He was killed by a common splinter,
Quite in the middle of the Winter;
Perhaps it was not at that time,
But I could find no other rhyme?

"Quite in the middle of the winter" describes August 3, 1460 A.D., with no wider licence than we find assumed in the works of more experienced, if less candid, artists and craftsmen. Again in her sonnet to a monkey—written, we must remember, when she was six or seven years of age—she acknowledges the compelling power of an artistic aim:—

"His nose's cast is of the Roman:
He is a very pretty woman.
I could not get a rhyme for Roman
So was obliged to call him woman.

It may seem that I have wandered widely from my text: those who found discourses on texts usually do! But there is, or ought to be, a closer connection than is usually recognised between the work of the engineer and that of those to whom we usually restrict the title of artist. There was no great gulf fixed between the fine arts and the utilitarian arts in earlier times. Some at least of those to whom we owe the greatest advances in the fine arts were eminent also in the arts of construction. We may claim such men as Michelangelo, Raphael, and Leonardo da Vinci as masters in the arts of construction as well as in those with which their names are usually associated. The separation of the beautiful and the useful is quite a modern vice. But much that I have ventured to say in the digression—if such it be—is applicable, with little or no alteration of terms, to the work of our own profession. The architect or engineer who, for the sake of effect, fills the space between the flanges of a beam or girder with slabs of stone, or cast-iron pillars and arches, that could not fulfil the function of a web, exhibits just the same lack of skill as Pet Marjorie owns up to—shall I say?—like a *man*. Such practices have no "basis in reason and propriety," and the employment of such "decorative features" is certainly not a "grouping of elements with science." It is said that "The highest art is to conceal art"; the lowest in matters pertaining to our profession is to conceal ill-devised construction with false and senseless masks. But what I have said has, I think, a sufficiently obvious bearing on the mechanical arts—I need not further point the moral.

There is an old maxim to the effect that "the designer should ornament his construction and not construct his ornament." This is an admirable rule so far as it goes, but it should be subordinated to a higher rule, that he should ornament his structure only if he lacks the skill to make it beautiful in itself. A structure of any kind that is intended to serve a useful end should have the beauty of appropriateness for the purpose it is to serve. It should tell the truth, and nothing but the truth, and if its character be such that it can be permitted to tell the whole truth, so much the better. It should be beautiful in the sense in which we commonly use the term with respect to a machine—we call a mechanical device beautiful only if it strikes us as accomplishing the end for which it is designed in the simplest and most direct way. Our works—like the highest creations in nature—should be beautiful and not beautified. "Beautified" should be considered a vile phrase when applied to a work of construction, no less than when used to characterise a fair Ophelia. Artists accept the human form, at its best, as the highest embodiment of grace and beauty, but there is not a curve in the figure that is not the contour of some structural detail that is there for a definite purpose. The practice of resorting to extraneous adornments to minimise crudities of structural scheme had its rise—if I mistake not—in the comparatively recent times when culture and taste were at their lowest. It is specially characteristic not only of earlier times, but of the earlier stages of the design of any particular product. It has already disappeared in some cases, and will continue to disappear from the practice of the arts of construction as skill and taste develop. I have already alluded to the abandonment of ornament in the design of machines, and I think there can be no one, with any sense of the fit and pleasing, who does not approve this change in practice. The stage coach and horses of former times were lavishly decorated—the carriage of to-day is more graceful and pleasing in virtue of the simple elegance of its lines. In the best domestic architecture of to-day we see the same tendency to trust for effect, more and more, to an artistic grouping of the lines and masses of essential parts and the gradual abandonment of purely decorative features, without and within. There was a time when the hulls and riggings and sails of ships were lavishly ornamented; now even the figurehead—the last remnant of barbaric taste—has disappeared; and do we not find in a full-rigged ship of to-day (or yesterday, perhaps one should say) a grace and dignity that no extraneous embellishments would enhance? From the racing yacht the designer has been forced, by the demand for efficiency, to cast off every weight and the adornments that so beset the craft of earlier times, with the result that there is left only a beautifully modelled hull, plain masts, and broad sweeps of canvas, and we can scarcely imagine any more beautiful or graceful product of the constructive arts. These examples will serve to illustrate the contention that the attainment of the highest efficiency brings with it the greatest artistic merit. But in the development of the yacht of to-day, through many stages, the designer has been forced, from time to time, to strive to combine grace with efficiency. Selection on the part of clients must have eliminated ungraceful forms when more beautiful ones could be found, and therefore the advance has been rapid. I think I may appeal to this illustration to support the further contention that advance in efficiency may be helped and not hindered by keeping in view an æsthetic as well as a utilitarian aim. Further illustrations will occur to anyone who has studied the development of design of structures or machines.

It is a matter of constant remark, and with justice, that steel bridges, as a class, are much less pleasing to the eye than those of stone. The reasons for the contrast in artistic merit are not far to seek. The building of stone bridges is an ancient art, and survival of the fittest, and selection—even with little creative skill on the part of the designers—would have led to the development of types having, of necessity, at least the elegance of fitness. But further, this art has come down through the times to which I have referred when artistic and utilitarian aims had not yet been divorced, in the practice of the crafts; and further still, the practice of building in stone has been in the hands of architects as well as of engineers, and architects are expected to be artists, and are trained as such. On the other hand, construction in steel is a very modern art, and it has been in the hands of engineers who usually neglect, if they do not despise, the study of the fine arts. But why have architects, with their artistic training, not succeeded in producing structures in steel as admirably as those they design in stone? Partly, no doubt, because they are hampered by tradition. They have not yet fully realised the difference in spirit that must characterise fit designs in the newer and the older materials. No one can be an artist in any material the possibilities and limitations of which he has not fully mastered. Again—if a common engineer may venture the criticism—the architect, as a rule, has not sufficiently mastered the *science* of construction, and has been too much addicted to taking the easy course of adopting a decorated treatment instead of striving to secure elegance of structural scheme as such; and decoration, at least on anything like traditional lines, is wholly incompatible with the best possibilities of steel as a structural material. Progress is being made in the art of designing efficient and graceful structures in metal, but the best results can only be attained by a designer who has a thorough scientific and technical knowledge of the properties of steel and the processes of its manipulation on the one hand, and cultured artistic sense and capacity on the other. These should not be considered as appropriate equipments for separate professions.

There are many, however, who have a rooted conviction that structures in steel can never be so beautiful as those in stone. This I believe to be altogether wrong. It arises partly from the crudity of design that characterises most of the steel structures that have yet been erected, and partly from preconceived notions as to what is fitting in proportions and massiveness. We can quite imagine that a native of the Congo region whose notions of the proportions suitable and comely for a quadruped were founded on his familiarity with the hippopotamus would, at first sight, consider the racehorse sadly lacking in substance and solidity; but, in time, he might come to recognise some measure of gracefulness in a creature that has been developed to meet requirements that hitherto he had not fully considered.

Mr. Wells has said in his "Modern Utopia," "the world still does not dream of the things that will be done with thought and steel when the engineer is sufficiently educated to be an artist, and the artistic intelligence has been quickened to the accomplishment of an engineer." But we need not postpone until the advent of a complete Utopia, the full realisation of our duty to practise our profession, as far as in us lies, with due regard for the material interests and the æsthetic susceptibilities of all who can be affected by the works for which we are responsible.

NOTES.

A PUBLIC meeting will be held at the Mansion House on Wednesday, October 23, in support of the memorial to Lord Lister.

THE superintendent of the Meteorological Office Observatory at Eskdalemuir, near Langholm, Dumfries, reports that the seismographs at the observatory recorded a large earthquake at 11.30 p.m. on September 13. The centre of the disturbance is indicated at latitude 40·4° N., longitude 27° E., a point situated at the south coast of the Sea of Marmora.

WE learn from *The Lancet* that the Riberi prize of the University of Turin, amounting to 20,000 lire (about 800*l*.), will be awarded after the close of the year 1916 for the work which is adjudged to have most advanced the science of medicine. Such work, if published, must have been printed after 1911. Or it may be sent in before the end of 1916, in print or typoscript—the English language is admissible. Further information may be obtained from Prof. Dr. Oliva, Turin.

A SPECIAL number of the *Atti della R. Accademia dei Lincei*, containing the report of the proceedings at the anniversary meeting last June, announces a gift of 4000*l*. from Dr. Gino Modigliani towards the publication of the works of Leonardo da Vinci, and a legacy to the academy of 2000*l*., as well as of many of her personal effects, from the estate of the late Signora Celli Dutuit. Prizes given by the King of Italy have been awarded to Prof. Ernesto Manasse for mineralogy and geology, and to Prof. Giuseppe Chiovenda for jurisprudence and political science. The Minister of Public Instruction also gives four prizes, each of which has this year been divided, the recipients being Profs. G. Ercolini and A. Amerio for physics, Profs. A. Quartaroli and R. Salvadori for chemistry, and Profs. Enrico Carrara, Donadoni Eugenio, Levi Ezio, and Ribezzo Francesco for the two philology prizes. A prize founded by Santoro is awarded to Prof. Costantino Gorini for his discoveries in the bacteriology of cheese, while another most useful prize, founded by the late Alfonso Sella for assistant lecturers in the department of physics, is awarded to Dr. Paolo Rossi, of the University of Naples.

WE announced with regret last week the death on September 4, at forty-two years of age, of Dr. Stanley Dunkerley, formerly professor of engineering in the University of Manchester. Dr. Dunkerley was educated at the Burnley Grammar School and Manchester University, where he graduated in 1900 with honours in mathematics, and took, a year later, the degree in engineering. After two years on the construction work of the Manchester Ship Canal, he obtained the Bishop Berkeley fellowship, and returned to the University to carry out researches in the Whitworth Engineering Laboratory under the direction of the late Prof. Osborne Reynolds. Dr. Dunkerley held appointments as assistant-lecturer in engineering at Liverpool University and at Cambridge. In 1897 he was appointed professor of applied mechanics at the Royal Naval College, resigning in 1905 to succeed Prof. Osborne Reynolds at the Manchester University. He had only held this post three years when ill health compelled him to resign. Dr. Dunkerley was strongest on the mathematical side of engineering. His most important contributions to engineering science are the paper on the whirling and vibration of shafts published in the Transactions of the Royal Society, and an investigation of the straining actions in crank shafts, which appeared in the transactions of the Institute of Naval Architects. He was the author of text-books on mechanism and hydraulics. In 1905 his University conferred on him the doctor's degree in science, and in the same year he was elected a member of the Institution of Civil Engineers.

THROUGHOUT the wide circle of mining engineers the announcement of the death of Mr. J. A. Chalmers at Bournemouth, on September 9, will be deeply regretted. Born in 1864, son of the Rev. Dr. Chalmers, an esteemed missionary in China, Mr. Chalmers in 1889 took his diploma as an Associate of the Royal School of Mines, and left the same year to take up professional duties in the Transvaal. There he afterwards became an assistant engineer to the Consolidated Goldfields of South Africa, under J. H. Hammond. Apart from the important work which came to him in this connection upon the Rand, Mr. Chalmers, with Dr. F. H. Hatch, accompanied Mr. Hammond when, in 1894, this engineer made an important mining reconnaissance into Rhodesia, a land which had not at that time long been under British influence. Later, in the year 1895, he collaborated with Dr. Hatch in the preparation of "The Gold Mines of the Rand," the first important work on the Witwatersrand Goldfields. Mr. Chalmers was thus by his own good work forced to the front, and during the next ten years important commissions took him for their fulfilment to all parts of the world. Then it was found that a disease, all unsuspected, had taken a hold on him that attention and skill could do nothing to loosen. Slowly but surely Mr. Chalmers sank, Davos put off the day, Bloemfontein the hour, but six weeks after his return to this country death came, at the early age of forty-eight. During all this time the many friends which his modesty had made for him failed not in frequent inquiry, and now that he has gone all mining engineers, even the most self-assertive, will cherish the memory of this man of quiet quality.

The new Allegheny Observatory, situate in Riverview Park, Pittsburg, was dedicated on the afternoon of Wednesday, August 28, in the presence of the members of the Astronomical and Astrophysical Society of America and of many of the Pittsburg friends of the institution. The principal instruments of the new observatory are a 13-in. visual refractor, a 30-in. reflector (a memorial to the late James Edward Keeler), and a 30-in. photographic refractor (a memorial to William Thaw and his son, William Thaw, jun.). The last of these telescopes is not quite completed, as the objective remains to be supplied. Addresses were given by Dr. John A. Brashear, chairman of the observatory committee; by Dr. Samuel Black McCormick, Chancellor of the University of Pittsburg, of which the observatory forms the astronomical department; by Dr. Frank Schlesinger, director of the Allegheny Observatory; and by Prof. E. C. Pickering, director of the Harvard College Observatory. Mrs. William Reed Thompson, the daughter of William Thaw and the sister of William Thaw, jun., closed the ceremony with the unveiling of the memorial tablet on the Thaw telescope.

The objections which were indicated some time ago in *Engineering* to the style of monoplane which is dependent on the rotary type of engine have been illustrated by the death of four army officers in one week, and give occasion for a strong article in our contemporary for September 13. The French Deperdussin monoplane, in which Captain Hamilton and Lieutenant Stuart lost their lives, broke in the air; as this machine won the 2000*l*. prize in the War Office competition it is not unreasonable to suppose that it represents the most advanced stage of monoplane construction. Its failure shows that however much care may be exercised in the choice of a monoplane of the ordinary type, it cannot be absolutely trusted to last for a month without breaking in mid-air. The cause of the failure of the Bristol monoplane, in which Lieutenants Hotchkiss and Bettington were killed, was not brought to light at the inquest. The Deperdussin failure, it seems to be generally agreed, was caused by some part of the revolving engine failing and wrecking the aëroplane. A real endeavour should be made to secure a supply of engines of other than the revolving type. Where this type has to be used some provision should be made for safety in case of parts breaking. This might be done by placing a strong shield between the engine and any parts it might otherwise damage.

At the French Army manœuvres some portable apparatus for wireless telegraphy on aëroplanes, designed by M. Rouzet, is being officially tested under war conditions. M. Rouzet's apparatus, which was described recently by the Paris correspondent of *The Morning Post*, embodies the novelty—so far as aëroplane work is concerned—of using a rotating spark-gap. This consists of a fixed and a movable disc each carrying a number of metal points between which the sparks pass while the movable disc is rotated rapidly. The disc, and also a small alternator, are driven by the aëroplane motor, and the current, which is generated at a pressure of 110 volts, is raised to 30,000 volts by a transformer, and led to a condenser and to the gaps. By setting the disc properly with respect to the dynamo windings and poles, the sparks can be made to occur when the condenser is just fully charged. The advantages of this mode of operation are, of course, very well known as regards larger units, but it seems that rotating spark-gaps have not been used before in French aëroplane work. The oscillations produced by the discharge of the condenser through the spark-gap are transferred to the antenna by means of a high-frequency auto-transformer of the Oudin pattern. The antenna consists of an aluminium wire 100 ft. long, and can be rolled up or unrolled by the operator by aid of a small winch, while provision is made whereby the pilot can cut the antenna adrift in case of necessity. Instead of the earth connection employed in a land or ship station, a wire network is, as usual, spread along the wings of the aëroplane, and thus the antenna and its "electrical counterpoise" constitute a self-contained Hertzian oscillator. The power of the dynamo is 200 watts, and the distance already worked over is between fifty and sixty miles.

A lecture on non-operative methods as applied to cancer was delivered by Prof. V. Czerny, of Heidelberg, on September 16, before the Association of German Naturalists and Physicians at Münster, in Westphalia. From a report in *The Morning Post*, we learn that Prof. Czerny confessed at once that a specific cure for cancer had not yet been discovered, and perhaps never would be found. Every year, he said, we hear of new discoverers who promise more or less infallible results, but close examination of their specifics shows their worthlessness. Within the last year or two chemical therapeutics had received a fresh impulse of scientific value owing to the results of experiments on animals, and it was now tolerably certain that blood treatment must take the place of the former treatment of stomach and intestines. Turning to ray therapeutics, Prof. Czerny admitted its efficacy after the knife in removing injuries, but was not inclined to attach very great importance to electricity applied as rays. In his opinion the more remedies we are confronted with the more difficult it is to find one's way to a proper treatment. This, he said, should be the work of the numerous institutes springing up in various civilised lands the express object of which is the study of this terrible scourge. On the whole, says the correspondent of *The Morning Post*, the address was couched in rather pessimistic tones, and the lecturer did not seem to share the hopeful views which have been lately expressed regarding the chemical, as opposed to the operative, treatment of the disease.

IN *The Popular Science Monthly* for August Prof. Richard Pearce gives an interesting historical survey of research in medicine, and Dr. Heinemann discusses cold-storage problems. The latter states that with careful treatment there are no appreciable differences in chemical composition between fresh meat and meat kept frozen for a period of two years.

IN the Farmers' Bulletin, No. 487 (U.S. Department of Agriculture), by Dr. Langworthy and Caroline Hunt, cheese and its economical uses in diet are considered. A number of recipes for the preparation of cheese dishes is given, and it is stated that cheese does not differ materially in its digestibility from meat, and, weight for weight, contains rather more protein and 50 per cent. more fat than cooked beef, and hence is a valuable food.

WE have received the August and September numbers of *The Child*, a monthly journal devoted to child welfare. Each contains a number of articles of general and special interest to those who have to deal with children—parents, educationists, doctors, and health visitors—notably one by Dr. Mary Scharlieb on adolescent girls from the point of view of the physician, in which the characteristics and management of adolescent girls are critically considered.

DETAILS are given of an improved respiration calorimeter, and the results of experiments with it by the U.S. Department of Agriculture (Exp. Station Record, vol. xxiv., No. 7, and Year-book for 1910). The influence of mental activity on metabolism was one of the subjects investigated, and in half the cases at least sustained mental effort had no positive influence upon the transformations of matter and energy within the body. The gaseous exchange and energy metabolism during the ripening of picked fruit, the germination of seeds, and the incubation of eggs are other subjects under investigation.

IN the August *Fortnightly Review*, Mr. Adolphe Smith discusses the present menace of cholera. He points out how cholera has been more or less prevalent on the Continent in various districts during the last three or four years, and directs attention to the danger that exists of the introduction of the disease into this country, particularly by way of some of the smaller ports, where sanitary administration is still very inadequate. He pleads for the establishment of a Ministry of Public Health, and for the burden of port sanitary administration to be placed on the country as a whole, and not on the local authority. Finally, he maintains that despite improvements in water supply, sewage disposal, and general sanitary conditions, poverty is the most potent of all those grim allies that join together to render devastating epidemics possible!

A RECENT number of the Annals of Tropical Medicine and Parasitology (vol. vi., No. 2) contains the results of investigations by H. B. Fantham and Annie Porter upon the destructive bee disease commonly known as "Isle of Wight Disease," together with a detailed description of the parasite and its life-history. The parasite, *Nosema apis*, belongs to the order Microsporidia, and is a close ally of *N. bombycis*, the parasite of silkworms, which causes the disease only too well-known as "pebrine," the subject of memorable researches by Pasteur. The method of infection was found to be contaminative; hereditary infection through the egg, as in *N. bombycis*, though by no means improbable, has not yet been proved to occur. The only certain means of destroying the resistant spores of the parasite and eradicating the infection is by fire. It is to be regretted that the authors should have thought it necessary to complicate the bibliography of Protozoa, already sufficiently vast, by setting forth their important results in three distinct and separate memoirs, which, as they are printed successively in the same journal, might easily have been included under one title.

MR. LUDWIG GLAUERT describes, in the first volume of the Records of the Western Australian Museum and Art Gallery (Perth, 1912, p. 47), an important series of remains of extinct marsupials from Balladonia. Eight of the species have not been recorded previously from Western Australia. The author supports Owen's view that Thylacoleo, the "marsupial lion," was carnivorous, and illustrates the worn enamel of its incisors.

To the July issue of *The Agricultural Journal of India* Mr. T. B. Fletcher, entomologist to the Madras Government, communicates an article, illustrated by a coloured plate, on termites or white ants. At the commencement reference is made to the modern view that these insects are not Neuroptera, but are more probably related to cockroaches and other Orthoptera, termites and cockroaches having many structural peculiarities in common. Then follows a full account of termite social economy.

A SHORT time ago the editor of *Popular Mechanics* (U.S.A.) conceived the idea of taking the votes of a number of scientific men on what inventions they considered to be the "seven wonders of the modern world," and for this purpose a list of numerous inventions was circulated, from which seven had to be selected. The result is published in the August number, and the seven inventions which received the highest number of votes are as follows:—Wireless, telephone, aëroplane, radium, antiseptics and antitoxins, spectrum analysis, X-ray.

WE learn from the daily Press that considerable anxiety is felt in France regarding the frequent deaths that have recently occurred through eating poisonous fungi. Three precautionary measures are suggested. One is to avoid gathering mushrooms having a persistent volva at the base of the stem; another is to boil every mushroom in water with a little salt; and a third is to have some animal charcoal at hand to be swallowed when a case of poisoning occurs. It is stated in the notices that no species is poisonous in which the volva is absent. It would be, however, wrong to regard all such species as esculent, for several well-known kinds having this characteristic certainly produce temporary, if not fatal, poisoning, at least unless subjected to prolonged boiling.

Two useful lists of South African plants have recently been published. Mr. J. Burtt-Davy and Mrs. Reno Pott-Leendertz (Annals of the Transvaal Museum, vol. iii.) have compiled a "first check-list" of the flowering plants and ferns of the Transvaal and Swaziland, enumerating about 3300 species. Mr. F. Eyles (*South African Journal of Science*, vol. viii.) gives a preliminary list of the plants of southern Rhodesia, comprising about 1700 flowering plants and ferns.

A NEW and curious species of "ground bean" (*Kerstingiella geocarpa*, Harms) from tropical West Africa is described and figured in the Kew Bulletin, No. 5, 1912. When the flowers are fully developed they are close to the ground, and after fertilisation the hitherto short stalk of the ovary lengthens into a long "carpopodium," which turns down and drives the young pod into the ground, where it matures. The same number contains a description and fine plate of a remarkable new spurge (*Euphorbia multiceps*, Berger) received at Kew from South Africa; it resembles a green pineapple with a number of spikes protruding irregularly from it, the stout fleshy axis being densely covered with short coral-like horizontal branches—the spikes are barren inflorescences, but no flowers have been seen. There is also a useful compilation of the various timbers and trees to which the terms tulipwood and tulip tree have been applied, just as other names (gum, rosewood, cedar, pine, mahogany, &c.) are indiscriminately applied to diverse timbers and trees.

MR. CECIL H. HOOPER has contributed to *Irish Gardening* for June and July an account of some interesting experiments on the pollination of hardy fruits, made by himself, Mr. F. Chittenden, and others. These experiments were made in order to ascertain whether fruits can set and mature without the aid of bees, whether mature fruit can be obtained by pollination with the pollen of the same variety or the same flower, and whether better fruits result from pollination with pollen of another variety. It was found that gooseberries and currants, raspberries and loganberries, though freely self-fertile, set better fruit when visited by bees; that strawberries are apparently to some extent wind-pollinated, though this needs confirmation. As is well known, more or less complete self-sterility is common among the many varieties of cherry, plum, apple, and pear; in the majority of cases pollen from another variety is essential for fruit formation. Details are given of numerous interesting results obtained by covering otherwise untouched flowers with muslin bags, by brushing with pollen from the flower's own anthers or from those of other plants of the same variety, and by pollination with pollen from other varieties. In connection with the interplanting of different varieties in orchards, lists are given according to the times of flowering. The author estimates that about 80 per cent. of the pollination of hardy fruits is done by the hive bee, about 15 per cent. by the various humble bees, and the remainder by miscellaneous insects.

THE meteorological year-book for Bremen, 1911, one of the regular German series, contains two important summaries in addition to the observations for the year in question:—(1) A discussion of the daily maximum and minimum temperatures for 1890–1910 (twenty-one years) by Mr. J. Siedenburg; and (2) monthly tables of the climate of Bremen for 1876–1910 (thirty-five years). This long series gives an absolute maximum temperature of 93·9° in May and an absolute minimum of −13·0° in December, but a reading of −17·1° is quoted as having occurred on January 23, 1823. The heat and drought of 1911 lasted from July 4 to September 27 (twelve weeks). Prof. Grosse ascribes the abnormal conditions principally to the shifting of the Azores pressure maximum to the north-east, and possibly to some extent to the approximate occurrence of the minimum sunspot period.

IN the *Atti dei Lincei*, xxi. (2), 2, Prof. Augusto Righi describes experiments on the convection of ions produced by magnetic or magneto-kathodic rays. According to the author's hypothesis these rays cause some of the electrons to unite with positive ions, the combination behaving like a double star or the system formed by a planet and its satellite. Once formed, they are carried by magnetic action from regions of greater to regions of lesser magnetic force, where the elements again frequently become dissociated. To dectect the presence of these ions, Prof. Righi makes use of a small cylinder of paper suspended by a fibre in the magnetic field generated by a second induction coil. According to theory the ions, by their impact on the cylinder, should cause the latter to rotate in the same direction as the magnetising current of the coil, and this was observed to be the case.

CERTAIN formulæ relating to the pressure of fluids on oblique planes have been recently quoted as "Avanzini's law." Col. de Villamil has made several inquiries as to where these laws were published, and having failed to obtain the information from others, has taken the matter up himself, and publishes an abstract of Avanzini's work in *The Aëronautical Journal* for July. The work in question was published in the *Memorie dell' Istituto nazionale italiano* at Bologna early last century, and deals with experiments on the relations between the velocity of a plate in still water, the angle of attack, the position of the centre of pressure, the density of the fluid, the length and breadth of the plate. The paper is illustrated by copies of the original diagrams, and contains experimental data. There are, however, several errors which require correction in the formulæ.

THE annual report of the results of sight tests in the Mercantile Marine, for the year ending on December 31, 1911, just published as a Parliamentary paper (Cd. 6370), shows a slight increase in the percentage of failures, both in form and in colour vision, over the returns of the preceding year. 7309 candidates were examined, with 117 failures in form vision, none of whom were re-examined, and with 192 failures in the first examinations for colour vision, of whom 56 passed on re-examination. This gives a percentage of 1·89 failures in colour vision, as against 1·51 in 1910, and is the largest proportion yet recorded. The methods of testing employed were the same as in 1910, the recommendations of the Departmental Committee appointed in that year not having yet been acted upon. Those recommendations included the substitution of a dark brown test skein for the deep red at present in use, and the employment of a special lantern, designed by the committee, for all candidates. Preparations are being made to carry these alterations into effect at the earliest possible time, and they seem calculated to meet all reasonable objections to the tests hitherto employed. An article on the report of the committee appeared in NATURE of July 4 (vol. lxxxix., p. 453).

VOL. v. of the Journal of the Municipal School of Technology, Manchester, a record of investigations published by the staff and students during 1911, extends to nearly 300 pages. Like its predecessors, it shows the unique position as a centre of research in applied science occupied by the Manchester School amongst the technical schools of this country. Three of the nineteen papers reprinted deal with pure science, and of them that by Prof. Gee and Mr. Adamson, describing a neat and simple "dioptriemeter" for measuring the focal lengths of lenses by the deviation produced, may be specially mentioned. Of the technical papers, the most important are that on electricity meters, by Messrs. Ratcliff and Moore, read before the Institution of Electrical Engineers, that on the electrical theory of dyeing, by Mr. W. Harrison, who finds in the theory explanations of many facts previously not interpreted, and that on boiler economics by the use of high gas speeds, by Prof. Nicholson, who shows how boilers may be reduced in size about 30 per cent. without any diminution in their steam production. The journal is printed in the printing crafts department of the school, and its execution does credit to that department.

UNDER the title of "Geostatic Funiculars," Prof. A. F. Jorini, writing in the *Rendiconti del R. Istituto lombardo*, xlv., 13, gives a solution of the problem presented by a cylindrical tunnel subjected to earth pressure, the surface of the superincumbent earth being horizontal.

PROF. C. MATAIX's papers on aëroplane stability in the *Revista de la Sociedad matemática española* conclude with the July number. The author succeeds in satisfying the conditions for longitudinal but not lateral stability. The latter failure is due to the character of the systems of surfaces assumed in the investigation. If the author had studied a system furnished with two vertical auxiliary surfaces or fins, he would have had no difficulty in satisfying the necessary conditions, and it is to be hoped that readers of the paper will not accept the conclusion that *all* systems of planes are laterally unstable.

IN a paper read recently by Mr. Edwin O. Sachs, at the New York International Congress on the testing of materials, the author directs attention to the very small amount of scientific testing of reinforced concrete which has been carried out in Britain. Our public institutions have been very remiss, for there is practically nothing to place beside the elaborate researches carried out by engineering professors in the public laboratories of the United States, Germany, and France. The author thinks that it is almost hopeless to expect our Government or our engineering colleges to pay now any attention to the matter, so that we can only look for a continuance of the efforts of private bodies, such as the professional societies intimately concerned.

OUR ASTRONOMICAL COLUMN.

GALE'S COMET, 1912*a*.—The comet discovered by Mr. Gale on September 8 is apparently becoming brighter and travelling northwards. A second telegram from Kiel states that it was observed at Santiago on September 11, when its position at 7h. 49·2m. (Santiago M.T.) was:—

R.A. = 13h. 54m. 2·4s., decl. = 33° 10′ 50″ S.

Comparing this with the position at the time of discovery, we see that the comet moved about 4° 15′ to the east and 3° 20′ northwards in a little more than two and a half days. In a telegram announcing the discovery, Reuter's Agency gave the magnitude as 6; the Santiago observer reports it as 5, so that there is a possibility of the comet becoming a more or less conspicuous object in our evening sky. When discovered, the comet was about half-way between θ and ι Centauri, and is apparently travelling towards the neighbourhood of α Libræ; this region now sets at about 7 p.m.

In the *Astronomische Nachrichten* (No. 4601) Herr Prager describes the object seen at Santiago as round, diameter 2′, magnitude between 3 and 6, nucleus, no tail.

THE TOTAL SOLAR ECLIPSE OF OCTOBER 10.—From *The Observatory*, No. 452, we learn that the eclipse party from Greenwich, consisting of Messrs. Eddington and Davidson, with Mr. J. J. Atkinson as a volunteer, left for Brazil on August 30. They expect to make their observations from Christina, some 150 miles inland from Rio de Janeiro, and the programme includes the direct photography of the corona, the photography of the ultra-violet spectra of the corona and chromosphere, and an attempt to secure monochromatic photographs of the corona in the light of the corona line (λ5303). The observing station is some 3000 feet above sea-level.

THE PERSEID SHOWER OF METEORS.—His watches for meteors on August 10 and 11 having disclosed but very meagre displays, Mr. Denning is led to believe that something must have intervened to bring about a very marked decline in the splendour of this noted shower. In a table, appearing in No. 452 of *The Observatory*, he shows how very few Perseids are now seen as compared with a decade ago. In 1901, during two watches of $6\frac{3}{4}$ hours in all, he saw 104 Perseids, in 1907 (6 hours) he saw 101, and in 1909 (4 hours) 79. Last year only three Perseids were seen in $2\frac{1}{2}$ hours, while this year only fourteen rewarded his two watches of $2\frac{1}{4}$ and $1\frac{1}{2}$ hours respectively. The conditions were not good, but, when compared with the 252 Perseids seen in 4 hours in 1874, and 285 in 5 hours in 1877, it would appear that something more than poor observing conditions must be held accountable for the poverty of recent displays.

THE SOLAR CONSTANT AND CLIMATIC CHANGES.—In a third paper on climate and crops, published in the Bulletin of the American Geographical Society for August, Mr. Henryk Arctowski compares the temperature records made at Arequipa during the period 1900–10 with the Washington values for the solar constant, and finds evidence of agreement between them; he also shows that Arequipa is not exceptional. His results indicate that a departure of 1° F. in the monthly mean observed at Arequipa is due to a departure, of about 0·015, of the solar constant from its normal value. If this be true, a comparatively small, but permanent, lowering of the constant would account for such climatical conditions as existed during the Pleistocene Ice age. Mr. Arctowski also finds that the oscillations of temperature found in his data correspond to those of atmospheric pressure to which Lockyer assigned a mean period of 3·8 years.

THE LEEDS ASTRONOMICAL SOCIETY.—The Journal and Transactions (No. 19) of this society for 1911 contains reports of a number of papers read before the society. Among others, there is an interesting discussion of the mutual eclipses of the satellites of Jupiter, by Mr. Whitmell, a paper dealing with suitable observations for amateur astronomers, by Mr. Ellison Hawks, and a discussion of the structure and sidereal significance of nebulæ by the Rev. Ivo Gregg. The membership now totals seventy-five, and the average attendance at meetings is fourteen.

THE PERIOD AND ORBIT OF α PERSEI.—From measures of a number of radial-velocity spectrograms, secured at the Potsdam Observatory between 1900 and 1908, Dr. A. Hnatek has derived an orbit for the spectroscopic binary α Persei, which he publishes in No. 4599 of the *Astronomische Nachrichten*. The variability of the velocity of this star, although small, now appears to be established, and Dr. Hnatek's results indicate a very short period of 4·0938 days. The radial-velocity of the system is −3·43 km., the eccentricity of the orbit 0·47, and the length of the semi-major axis of the projected orbit 46,000 km.

NEW RULES FOR LIFE-SAVING APPLIANCES IN BRITISH SHIPS.

MR. BUXTON has lost no time in considering and giving effect to the recommendations made by Lord Mersey and his colleagues, as well as the report of the Advisory Committee. The character of these recommendations and of that report has been described fully in previous issues (see NATURE, August 8 and 29); it will suffice, therefore, briefly to indicate the most important points in the Parliamentary Paper (Cd. 6402) issued a few days ago, in which the new rules made by the Board of Trade are contained. Those rules will not have statutory effect until they have lain on the table of the House of Commons for forty days, and it is not proposed that they shall come into effect until January 1, 1913. It is practically certain that when Parliament reassembles the rules will be criticised, and it is possible that they may be amended in some respects as the result of that criticism.

Although the rules previously issued have been accepted without serious challenge, the circumstances of the present revision and the drastic nature of some of the new regulations may cause a departure from precedent. Mr. Buxton has recognised the special conditions of the revision of the rules, and has wisely prefaced them by an explanatory memorandum which is both comprehensive and clearly expressed. His memorandum gives the history of the steps which have been taken by the President of the Board of Trade to deduce all possible lessons from the loss of the *Titanic* in order to secure greater safety in future for life and property at sea.

It is also, in effect, an attempt to justify the rules themselves in those features wherein the report of the Advisory Committee has been departed from. That report has been dealt with somewhat harshly by critics, who are disposed to think that shipowners serving on the committee have been unduly influenced by consideration of their class-interests. There is no real foundation for such an opinion, and Mr. Buxton marks his dissent therefrom by stating that, although he has been unable to adopt the conclusions of the committee on some material points, its report has been of very great value, and that he desires to express a high appreciation of the time "and pains expended by the members of the committee and of its various subcommittees on the important questions referred to them." Nothing but prejudice could lead to the conclusion that the shipowners and shipbuilders, who have given gratuitous and unstinting service on these inquiries, would have allowed personal considerations to weigh with them. On the contrary, it is clear that no classes of the community can have a greater interest in securing safety at sea, and certainly no other persons have done so much during the last twenty-five years to increase that safety.

The main point of difference between the Advisory Committee and the new official rules is to be found in the provision that foreign-going passenger and emigrant ships are in future to have sufficient *lifeboat* accommodation for all on board; whereas the committee recommended that lifeboats should be supplemented by rafts, collapsible boats, &c. It is intended further to consider the extent, if any, to which life-rafts may be used when the report of the Davits and Boats Committee—which is about to commence its labours—has been received. Collapsible boats are not to be included in future estimates of life-saving accommodation, although they may be continued in use in existing vessels for a certain period—not specified. On this point there will be debate, and there is reason for difference of opinion. Whatever the final decision may be, it should be noted that there is now universal agreement that in all cases, even in the best subdivided foreign-going ships, *every soul on board shall have a chance of keeping afloat* in boats, rafts, or other appliances, in case a ship founders through collision, grounding, or other accident. For ships in the home trade less stringent provisions are insisted upon in respect of life-saving accommodation, and this course is reasonable having regard to the restricted range of their employment and the greater chance of external help in case of accident.

What remains to be demonstrated—and the task will not be an easy one—is whether the large number of lifeboats now thought to be essential can possibly be so carried as to be loaded and got into the water safely within a reasonable time after an accident has taken place—say within half an hour or an hour. Judging by the *Titanic*—in which case all the circumstances were most favourable to the loading and lowering of boats—radical changes will be required in the installation of lifeboats and in the means of lowering them, if this essential condition is to be fulfilled. All that need be added is that whatever may be the number of lifeboats carried, and however efficient may be the details of the arrangements for lowering these boats, it is obviously of primary importance to secure efficient watertight subdivision in passenger ships, so as to minimise the risk of foundering and to lengthen out the time which ships will remain afloat in cases of accidents so serious as to involve their final sinkage. On this matter another committee is still at work, and no action can be taken by the Board of Trade until its report has been presented.

ATMOSPHERIC PRESSURE AND TEMPERATURE.

IN *Aus dem Archiv der deutschen Seewarte*, 1911, No. 4, W. Brockmöller discusses the geographical distribution of the monthly range of oscillation of the barometer. So far as the southern hemisphere is concerned, the question was thoroughly investigated by Dr. W. J. S. Lockyer in a recent publication of the Solar Physics Committee, but Herr Brockmöller's treatment of the subject covers a wider area, and is based on a different definition of the "range." He takes as the measure of this the mean value of the difference between the highest and lowest barometer readings for each month, and deals with a selection of stations, about 300 in all. After correcting the values for the periodic semi-diurnal variation, and for height above sea-level in the case of a few high-level stations, he plots the values for winter (December–February), and for summer (June–August), and obtains two very interesting charts, showing the isobarometric lines, or lines of equal range. For the northern hemisphere he obtains also normals for different latitudes, and draws the isanomalies, or lines of equal departure from normal. The range is least, 3 or 4 mm., in the equatorial region, and greatest near the arctic circle, apparently diminishing again towards the pole. The outstanding features are the maxima, in both seasons, near Iceland and the Aleutian Islands, the regions of the "permanent cyclones." The maxima are naturally much less intense in summer than in winter. Perhaps even more remarkable is the large value of the anomaly on the east coast of North America, where it is greater than at any other place. The effect is possibly due to the proximity of the division between the Labrador current and the warmer water of the North Atlantic, but it is deserving of further investigation.

In the same journal, No. 5, Prof. Köppen and Dr. Wendt discuss the vertical distribution of temperature over Hamburg between the earth's surface and a height of 3000 m. The records obtained in nearly 1200 ascents of kites and balloons during the years 1904–9 have been analysed very thoroughly, and a new departure has been made in the special treatment of so-called inversions of temperature-gradient. The authors find that such inversions occur in 69 out of every 100 ascents, the temperature remaining constant or increasing with altitude. Inversions are most frequent in autumn and winter, and in December they are found in nearly every ascent. At all seasons they occur most frequently with southerly winds. Inversions in which the increase of temperature exceeds 3° C. are almost invariably accompanied by a decrease in the relative humidity except for those which occur in the layer between the earth's surface and a height of 500 m. At all seasons the sky is more frequently cloudy than clear on the occasions when inversions are recorded, but in spring and autumn the number of cases of clear sky is large. The clouds were found usually to have their lower surfaces below 500 m., *except in those cases in which inversions occurred below* 500 *m.* Another section of the paper deals with the dependence of temperature-gradient on wind direction. Near the surface the gradient is greatest with N. winds, above 500 m. with W. winds, and above 1000 m. with S.W. winds. As the wind usually veers with increasing height, it seems probable that the actual direction of the current for maximum gradient in the layer considered will be northerly at all heights.

PLANKTON INVESTIGATIONS.

IN the *Bulletin Trimestriel*, 1911, the second part of the "Résumé des Observations" continues the summary of the plankton investigations carried out under the international programme in the north-east Atlantic and north-west European waters during the years 1902–8. The subjects here dealt with are the Copepoda, Tunicata, Ostracoda, Chætognatha, Amphipoda, Rotatoria, and Ceratium. With the vast amount of material collected in course of the investigations external records are incorporated in a discussion of the seasonal occurrence and distribution of the species considered, and the hydrographic conditions associated in each case with such. The annual and seasonal distribution and intensity of many of the more important species are shown in a number of separate charts. From an economic point of view, attention is directed to the importance of many of the Copepoda and Amphipoda as constituting in a large measure the food supply of Clupeoids, Gadidæ, the mackerel, and other marketable fishes.

As bearing directly on questions of physical oceanography, Salpa and Doliolum among the Tunicata afford important examples of warm-water species drifted as annual visitors to our coasts by the agency of the Gulf Stream. Similarly, several species of Ceratium show a distribution largely increased by immigration through the Faroe-Shetland Channel into the North and Norwegian Seas and beyond. Some of the latter species have a second sphere of distribution in the West Atlantic, from Florida to Newfoundland, and the author of this section, who has traced some of them sparingly at wide intervals across the Atlantic to the American coast, is of opinion that the two spheres of distribution are indeed in communication by virtue of the east-going oceanic movement. Conversely, among the brackish-water Rotatoria, species find their extension during the summer months from the Gulfs of Finland and Bothnia over the Baltic and outwards, mainly dependent on the periodic surface outflow of low-salinity water in this region. For the further elucidation of these complex problems, more exact information is required concerning some of the more critical species, and the need is felt, in particular, for a greater extension of the area of investigations to the westward and south-westward of Ireland.

THE PLACE OF MATHEMATICS IN ENGINEERING PRACTICE.[1]

THE foundations of modern engineering have been laid on mathematics and physical science; the practice of engineering is now governed by scientific methods applied to the analysis of experience and the results of experimental research. Engineering has been defined as "the art of directing the great sources of power in nature for the use and convenience of man." An adequate acquaintance with the laws of nature, and obedience to those laws, are essential to the full utilisation of these sources of power. It is now universally recognised that the educated engineer must possess a good knowledge of the sciences which bear upon his professional duties, in combination with thorough practical training and experience in actual engineering work. Neither side of his education can be neglected without hampering him seriously, especially when he has to go beyond precedent and face new problems. Of these sciences, the mathematical is undoubtedly of the greatest importance to engineers. The range and character of mathematical knowledge which can be considered adequate are gradually being agreed upon as experience is enlarged; and present ideas are embodied in the courses of study prescribed in the calendars of schools of engineering. Absolute identity in the course of study and the standards laid down for degrees in engineering has not been attained, but the approach thereto has already been considerable, and the movement will undoubtedly continue in the same direction.

The preponderance of opinion amongst engineers now favours the teaching to students of engineering of science generally, and of mathematics in particular, being undertaken by recognised authorities in the several branches, and on lines which shall ensure greater breadth of view and fuller capability for dealing with new problems arising in their professional work than can be secured by means of special courses of instruction arranged for students of engineering as a class apart. Whatever branch of engineering a man may select for his individual practice, he must need a fundamental knowledge of mathematics, and in some branches, in order to do his work well, he will require to add considerably to the mathematical knowledge which is sufficient for a degree.

As time passes the mathematician and the practising engineer have come to understand one another better, and to be mutually helpful. While engineers as a class cannot claim to have made many important or original contributions to mathematical science, some men trained as engineers have done notable work of a mathematical character. The names of Rankine, William Froude, and John Hopkinson among British engineers also hold an honoured place in mathematics. Mathematicians of eminence have spent their lives in the tuition of engineers, and in that way have greatly influenced the practice of engineering; but while they have necessarily become familiar with the problems of engineering as a consequence of their connection therewith, they have not accomplished much actual engineering work, and none of it has been of first importance. Speaking broadly, there is an abiding distinction between mathematicians and engineers. Mathematicians regard engineering chiefly from the scientific point of view, and are primarily concerned with the bearing of mathematics on engineering practice, the construction of theories, and the framing of useful rules. Engineers, even when well equipped with mathematical knowledge, are primarily devoted to the design and construction of efficient and durable works, their main object being to secure the best possible association of efficiency and economy, and so to achieve practical and commercial success. There is evidently room for both classes, and their collaboration in modern times has produced wonderful results.

The proper use of mathematics in engineering practice is now generally agreed to include the following steps: first comes the development of a mathematical theory based on assumptions which are thought to embody and to represent conditions disclosed by past practice and observation. Frequently these theoretical investigations give rise to valuable suggestions for further observation or experimental investigations. Mathematical analysis must be applied to the results of observation and experiment; and, as a result, amendments or extensions are made of the original mathematical theory. Useful rules are also devised, in many instances, which serve for guidance in the future practice of engineers. Formerly it was thought by men of science that purely mathematical investigation and reasoning would do all that was required for the guidance of engineering practice; now it is admitted that such investigations will not suffice, and that the chief services which can be rendered to engineering by mathematicians will consist in the suggestion of the best directions and methods for experimental research, the conduct of observations on the behaviour of existing works, the establishment of general principles based on analysis of experience, and the framing of practical rules embodying scientific principles.

The contrast between present and past methods can be illustrated by comparing investigations made during the eighteenth century into the behaviour of ships amongst waves by Daniel Bernoulli, who won the prize offered by the Royal French Academy of Science in 1757, and work done by William Froude a century later in connection with the same subjects. Bernoulli was the greater mathematician, but had only a small knowledge of the sea and of ships. His memoir was a mathematical treatise; his practical rules, although deduced from mathematical investigations which were themselves correct, depended upon certain fundamental assumptions which did not correctly represent either the phenomena of wave-motion or the causes producing and limiting the rolling oscillations of ships. Bernoulli realised and dwelt upon the need for further experiment and observation and showed remarkable insight into what was needed; but the fact remains that he neither made such experiments himself nor was able to induce others to make them. As a consequence, his practical rules for the guidance of naval architects were incorrect and would have produced mischievous results if they had been applied in practice.

William Froude was a trained engineer who had a good knowledge of mathematics and a mathematical mind. His acquaintance with the sea and ships was considerable, his skill as an experimentalist was remarkable, and he was fortunate enough to secure the support of the Admiralty through the Constructive Department. He thus obtained the services of the officers of the Royal Navy in making a long series of accurate and detailed observations of the characteristic features of ocean waves as well as the rolling of ships amongst waves or in still water. In this way, starting with the formulation of a mathematical theory of wave-motion, and of a theory for unresisted rolling in still water and amongst waves, Froude added corrections based on experimental research, and succeeded eventually in devising methods by means of which naval architects can make close approximations to the probable behaviour of ships of new design when exposed to the action of waves,

[1] Lecture delivered at Cambridge before the Fifth International Congress of Mathematicians by Sir William H. White, K.C.B., F.R.S.

either forming a regular series or constituting an irregular sea. In these approximations allowance can be made for the effect of water-resistance to the rolling motion—a most important factor in the problem which could not be dealt with until experimental research had been made, and results had been subjected to mathematical analysis. In addition, Froude laid down certain practical rules for the guidance of naval architects, and the application of these rules has been shown by long experience to favour the steadiness—that is to say, the comparative freedom from rolling—of ships designed in accordance with these rules. In short, a problem which had proved too difficult when attacked by Daniel Bernoulli in purely mathematical fashion was practically solved a century later by Froude, who employed a combination of mathematical treatment and experimental research.

Another example of the contrast between earlier and present methods is to be found in the treatment of the resistance offered by water to the onward motion of ships. From an early date mathematicians have been attracted to this subject, and many attempts were made to frame mathematical theories. When steam-propulsion for ships was introduced, the matter became of great practical importance, because it was necessary to make estimates for the engine-power required to drive a ship at the desired speed. In making such estimates it was necessary to approximate to the value of the water-resistance at that speed, although the required engine-power was also influenced by the efficiency of the propelling apparatus and propellers. In addition, it was obvious that the water-resistance to the motion of a ship when she was driven by her propellers at a given speed would be in excess of the resistance experienced if she were towed at the same speed, and there was no exact knowledge in regard to that increment of resistance. The earlier mathematical theories of resistance proved to be of little or no service, and they were based on erroneous and incomplete assumptions. Rankine devised a "stream-line" theory which was superior to its predecessors, but it also for a time had no effect on the practice of naval architects. William Froude, adopting this stream-line theory, dealt separately with frictional resistance, and devised a "law of comparison" at corresponding speeds, by which from the "residual resistance" of models—exclusive of friction—it became possible to estimate the corresponding residual resistance for ships of similar forms. At first he stood alone in advocating these views, but subsequent experience during forty years has demonstrated their soundness.

Experimental tanks for testing models of ships, such as Froude introduced, are now established in all maritime countries, and the results obtained therein are of enormous value to the designing of steamships. In regard to the selection of the forms of ships, naval architects are now able to proceed with practical certainty; but in connection with the design of screw propellers, even after model experiments have been made with alternative forms of screws, there is still great uncertainty, and dependence upon the results obtained on "progressive" speed trials of ships is still of the greatest service. As yet the "law of comparison" between model screws and full-sized screws has not been determined accurately. The condition of the water in which screws act, as influenced by the advance of a ship and her frictional wake, the phenomena attending the passage of the water through a screw, and the impression thereon of sternward motion from which results the thrust of the propeller, the effect upon that thrust of variations in the forms and areas of the blades of screw propellers, and the causes of "cavitation," all form subjects demanding further investigation. In these cases the only hope of finding solutions lies in the association of experimental research with mathematical analysis. There have been very many mathematical theories of the action of screw propellers, but none of these has provided the means for dealing practically with the problems of propeller design, and there is no hope that any purely mathematical investigation ever will do so, because the conditions which should be included in the fundamental equations are complex and to a great extent undetermined.

In connection with other branches of engineering, model-experiments have also proved effective. Examples are to be found in connection with the estimates for wind-pressure on complicated engineering structures, such as girder or cantilever bridges. Experimental methods are also being applied with great advantage to the study of aeronautics and the problems of flight.

The association of the mathematical analysis of past experience with designs for new engineering works of all kinds is both necessary and fruitful of benefits. A striking example of this procedure is to be found in connection with the structural arrangements of ships of unprecedented size, which have to be propelled at high speeds through the roughest seas, to carry heavy loads, to be exposed to great and rapid changes in the distribution of weight and buoyancy, and to be subjected simultaneously to rolling, pitching, and heavy motion, as well as to blows of the sea. In such a case purely mathematical investigation would be useless; the scientific interpretation of past experience and the comparison of results of calculations based on reasonable hypotheses for ships which have seen service with similar results of calculations for ships of new design are the only means which can furnish guidance.

In the past the association of mathematicians and engineers has done much towards securing remarkable advances in engineering practice; and in future it may be anticipated that still greater results will be attained now that the true place of mathematicians in that practice is better understood and utilised.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A great cause of anxiety to those who are responsible for evening continuation schools and classes lies in the spasmodic attendances and lack of continuity of the casual student. The prospectus of the Municipal Technical Institute, Belfast, shows that the authorities in that city deal with this source of trouble courageously. Students must submit to an entrance examination, and must follow a course of study, and "any student who does not wish to conform to the regulation as to attending a definite course of study or passing the entrance examination can obtain exemption on making application at the office and paying *treble* the fee for the class it is desired to join." Side by side with these restrictions there is every opportunity and incentive to the serious student to equip himself thoroughly for his business.

The London County Council announces that the evening classes held in Polytechnics, technical institutes, schools of art, commercial centres, and evening schools will shortly be reopened. The programme which the Council has prepared includes classes to meet all kinds of needs. The enrolment of students began on Monday, September 16, and a leaflet giving full particulars as to where the classes are held, and as to fees (which it may be stated are very low), can be obtained at any of the Council's schools and of the Education Officer, Education Offices, Victoria Embankment. It is hoped that the efforts of the Council to improve the education of the young people of London by means of these valuable classes will result in a large influx of new and earnest students in the session now at hand.

THE 90th session of the Birkbeck College will commence on Wednesday, September 25. The opening address will be given in the theatre at 7.30 p.m., by Sir Sidney Lee. The class-rooms, &c., will afterwards be open for inspection, and there will be an exhibition in the Art School. The college is conducted in relation with the University of London; classes are held both in the day and evening; twenty-nine members of the staff are recognised teachers of the University. There is a very complete curriculum for chemistry, physics, mathematics, botany, zoology, and geology. The laboratories are well equipped with modern apparatus and appliances, and research work is encouraged in all the science departments. According to the calendar more than 118 students passed some examination of the University during the last session: forty-nine took degrees in arts or science, twenty-two with honours, and several students gained distinction at other universities.

THE new session of the Battersea Polytechnic opened on Tuesday, September 17, and the calendar gives full details of all the numerous courses and classes held at the Polytechnic. In the Day Technical College full-time courses are arranged in mechanical, civil, electrical and motor engineering, architecture and building, chemical engineering, and art, the courses covering a period of three years, at the end of which time students passing the necessary examinations are awarded the Polytechnic diploma. There are also full university and diploma courses in mathematics, physics, chemistry, botany, &c. Concurrently with the diploma courses, students can prepare for and take the degree courses in science and engineering of the University of London. In the electrical engineering department, a new course in electric lighting and illumination will be held during the second term of the session. The greatest development to be recorded this year is in the department of natural science, *i.e.* including the subjects of hygiene, physiology, geology, and bacteriology. The recent donation of 6000*l.* made by the Worshipful Company of Drapers has enabled the governing body to erect a four-storey building for the housing of the above sections of work, and thus airy and well-lighted laboratories and lecture-rooms of the latest design, and fitted with the most modern equipment, are now available for this most important work.

AN influentially signed appeal has reached us for support to a scheme for providing a systematic course of combined military and industrial training for lads from the age of fourteen years upwards. The object of the British Boys' Training Corps, on behalf of which the appeal is made, is the moral, physical, and industrial advancement of the cadets enrolled in it, to train them in the duties of citizenship, and to fit them for a life of industry. Military organisation and exercise will be used as a means for developing their *moral* and physique, and promoting among them habits of discipline, application, adaptability, and resourcefulness, which are indispensable to proficiency in the workshop or the factory. The corps will, in effect, be a military and industrial boarding-school, and is designed to train and instruct a boy for a period of three or four years continuously from the time he leaves the elementary school. Alike upon social, economic, and industrial grounds the scheme is commended to the public. The annual loss to the nation of promising material presents a grave problem. Far too many boys on leaving school are engaged in "blind-alley" occupations; when they have outgrown these, they find themselves adrift without either the skill or the knowledge to qualify them for permanent employment; they swell the ranks of casual labour, and the prison or the workhouse is the ultimate destiny of an increasing number of them. To mitigate these evils in some measure at least is the aim of the corps. It is estimated that the cost of establishing and maintaining the corps at first will be 15,000*l.* No appeal for funds has hitherto been made, but two members of the council have generously promised to guarantee 1000*l.* and 500*l.* respectively towards the expenses on condition that the total amount guaranteed or subscribed is not less than 15,000*l.*, and various unsolicited donations, including an anonymous one of 50*l.*, have already been placed to the credit of the corps at the Bank of England. Guarantees, donations, or subscriptions may be sent to the account of the corps at the Bank of England (Western Branch), Burlington Gardens, W.; to Colonel Pollock, Wingfield, Godalming; or to the hon. secretary, Mr. J. C. Medd, 37 Russell Square, W.C., from whom particulars of the scheme can be obtained.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 2.—M. P. Appell in the chair.—A. **Lacroix**: The origin of the transparent quartz of Madagascar. The hyaline quartz of Madagascar is of complex origin, but there are only two classes of deposits furnishing the mineral in large quantities and of sufficient transparency for industrial purposes. One of these is in lodes of the Ampangabé type, in which the quartz is without crystalline form; the other is of hydrothermal origin, and here the quartz forms well-defined crystals.—A. **Riccò**: Filaments, *alignements*, and solar prominences. The author confirms the view that there is a relation between the prominences and the filaments and *alignements*.—Jean **Danysz** and William **Duane**: The electrical charges carried by the α and β rays. From the experiments described the electrical charge carried by the α rays of one Curie of emanation in equilibrium with radium A, B, C is deduced as 90·8 electrostatic units per second, or nearly three times the charge found by Rutherford for radium C alone in equilibrium with one Curie of emanation. From this constant are deduced the volume of one Curie of emanation (0·595 mm.^{3} at 15° C.), and the volume of helium given off by one gram of radium in equilibrium with its emanation and radium A, B, and C (157 mm.^{3}), both in good agreement with the experimental values. Victor **Henri** and René **Wurmser**: Study of the law of photochemical absorption for reactions produced by the ultra-violet rays. There is a striking parallelism between the absorption curve of acetone in the ultra-violet and the chemical activity of the different rays. This reaction affords an example where the extreme ultra-violet rays are less active chemically than ultra-violet rays of greater wave-length.—Claude **Verne**: *Solanum maglia* and *tuberosum*, and the results of experiments on cultural bud mutations undertaken on these wild species of potato.—H. **Busquet**: The comparative cardiac action of the physiological extract of digitalis and other digitalis preparations.—Romuald **Minkiewicz**: *Ciliata chromatophora*, a new order of Infusoria with unusual morphology and reproduction.—C. **Maltézos**: Contribution to the phenomena of lightning.

September 9.—M. P. Appell in the chair.—A. **Müntz**: The evaporation of the soil and of plants as a factor in causing the persistence of wet and cold weather.—Daniel **Berthelot** and Henry **Gaudechon**: The action of the ultra-violet rays upon gaseous hydrocarbons. Remarks on a recent note by Marc Landau.—Em. **Bourquelot** and M. **Bridel**: A new synthesis of the glucoside of an alcohol with the aid of emulsin. β-Benzylglucoside.—Ch. **Jolin**: The specific histological characters of the "luminous cells" of *Pyrosoma giganteum* and of *Cyclosalpa pinnata*.

NEW SOUTH WALES.

Linnean Society, July 31.—Mr. W. W. Froggatt, president, in the chair.—Rev. W. W. **Watts**: The ferns of Lord Howe Island. During a two months' stay, last year, Mr. Watts collected specimens of the unique fern-flora of the island. The paper indicated the species to be found on the northern hills, in the central area, and at the southern end of the island, where Mts. Lidgbird and Gower rise to a height of 2500 and 2800 ft. respectively. The plateau on the top of Mt. Gower is the home of a number of beautiful species to be found nowhere else.—R. J. **Tillyard**: Some new and rare Australian Agrionidæ (Neuroptera: Odonata). In this paper, a considerable number of new Australian species are described, and new genera are proposed for the reception of these and other species.—H. J. **Carter**: Descriptions of some new species of Coleoptera.

BOOKS RECEIVED.

Manuale di Fisica ad uso delle scuole secondarie e superiori. By Prof. B. Dessau. Volume Primo. Meccanica. Pp. xii+500. (Milano: Società Editrice Libraria.) 12 lire.

Mysore Geological Department. Report of the Chief Inspector of Mines for the Year 1910–11. With Statistics for the Calendar Year 1910. (Bangalore: The Government Press.) 2 rupees.

Practical Chemistry, including Simple Volumetric Analysis and Toxicology. By Prof. P. A. E. Richards. Second Edition. Pp. x+149. (London: Baillière, Tindall and Cox.) 3*s*. net.

Handwörterbuch der Naturwissenschaften. Edited by E. Korschelt and others. Lief. 14–18. (Jena: G. Fischer.)

Index of Economic Material in Documents of the U.S. Ohio, 1787–1904. Parts i. and ii. By A. R. Hasse. Pp. 1136. (Washington: Carnegie Institution.)

Department of Commerce and Labour. Coast and Geodetic Survey. Results of Observations made at the Coast and Geodetic Survey Magnetic Observatory at Vieques, Porto Rico, 1909 and 1910. By D. L. Hazard. Pp. 94+10 diagrams. (Washington: Government Printing Office.)

Modern Sanitary Engineering. By G. Thomson. Part i., House Drainage. Pp. xv+266. (London: Constable and Co., Ltd.) 6*s*. net.

The World's Cane Sugar Industry, Past and Present. By H. C. P. Geerligs. Pp. xvi+399+plates+maps. (Altrincham: N. Rodger.) 12*s*. net.

The Origin and Evolution of Primitive Man. By Dr. A. Churchward. Pp. 88+46 plates. (London: G. Allen and Co., Ltd.) 5*s*. net.

Science French Course. By C. W. P. Moffatt. Pp. x+305. (London: W. B. Clive.) 3*s*. 6*d*.

Home University Library:—The Human Body. By Prof. A. Keith. Pp. 256. The Making of the Earth. By Prof. J. W. Gregory. Pp. 256. Electricity. By Prof. G. Kapp. Pp. 256. (London: Williams and Norgate) Each 1*s*. net.

Bacon's New Globe, with Contour Colouring. (London: G. W. Bacon and Co., Ltd.) 25*s*. net.

British Plant-galls. By E. W. Swanton. Pp. xv+287+32 plates. (London: Methuen and Co., Ltd.) 7*s*. 6*d*. net.

Spiderland. By P. A. Ellis. Pp. xxii+108. (London: Cassell and Co., Ltd.) 3*s*. 6*d*. net.

Malta and the Mediterranean Race. By R. N. Bradley. Pp. 336. (London: T. F. Unwin.) 8*s*. 6*d*. net.

New South Wales. Historical, Physiographical, and Economic. By A. W. Jose, T. G. Taylor, and Dr. W. G. Woolnough. Edited by Prof. T. W. E. David. Pp. xii+372. (Melbourne: Whitcombe and Tombs, Ltd.) 4*s*. 6*d*.

Dizionario di Merceologia e di chimica applicata. By Prof. V. Villavecchia, Dr. G. Fabris, Dr. G. Rossi, and Dr. A. Bianchi. Terza Edizione. Vol. ii. Pp. 1360. (Milano: Hoepli.) 15 lire.

Bartholomew's New Reduced Survey Maps for Tourists and Cyclists. Sheet 9, Berwick and Haddington. Sheet 21, Inverness and Spey. (Edinburgh: J. Bartholomew and Co.) Each 1*s*. 6*d*. net.

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Lectures, Monday, 7.30. E. HINKS, B.Sc., F.I.C., and T. MACARA, F.I.C.

ELECTROCHEMISTRY. Wednesday and Friday, 7.30.

THE ANALYSIS AND VALUATION OF LAUNDRY TRADE MATERIALS.

A Practical Course, Monday and Friday, 7.30. C. DORÉE, M.A., D.Sc.

For full particulars apply to the Principal, C. T. MILLIS.

THURSDAY, SEPTEMBER 26, 1912.

SCIENTIFIC PEDAGOGY.

(1) *Rationalist English Educators.* By Dr. G. E. Hodgson. Pp. 254. (London: S.P.C.K.; New York: E. S. Gorham, 1912.) Price 3*s.* 6*d.*

(2) *The Montessori Method: Scientific Pedagogy as Applied to Child Education in "The Children's Houses."* With additions and revisions by the author. By Maria Montessori. Translated from the Italian by Anne E. George. Pp. xliii + 377. (London: W. Heinemann, 1912.) Price 7*s.* 6*d.* net.

(3) *The Evolution of Educational Theory.* By Prof. John Adams. Pp. ix + 410. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* net. (The Schools of Philosophy.)

(1) PROBABLY Miss Hodgson is by temperament incapable of entering sympathetically into the point of view of those of whom she writes in this volume—Locke, the Edgeworths, and John Stuart Mill. In any case she should show a more adequate acquaintance with the Edgeworths when she writes about them. In the first line of her essay she misquotes the title of the only book of theirs she refers to, and continues so to misquote it throughout her text. A competent reader will soon discover that she has missed the message of the book in her superficial *résumé* of its contents. It is therefore scarcely necessary to examine her criticisms. The treatment of Locke is the most satisfactory performance of the three.

(2) Mdme. Montessori's work for young children in the slum districts of Rome had received widespread recognition before the translation of her chief pedagogical writing appeared. The ground had in other ways been well prepared, and now we are threatened with a regular invasion of Montessori machinery. This is not said to belittle what has been accomplished in the "Children's Houses" in Rome. The idea of a central nursery for children from three to seven in the great tenement blocks was admirable in itself, and it was made still more so by associating the parents with its management and by appointing *directrices* who should live on the spot amongst those whom they were trying to serve. As a great social experiment, there is much to learn from Mdme. Montessori's success, whether it is the little school societies themselves which we regard, or the whole social setting of the establishments which she set up.

From the point of view of scientific pedagogy, the book and the experiment are interesting because of the sources of Mdme. Montessori's inspiration. Primarily a medical woman, the author made a special study of psychiatry, and took up the education of mentally deficient children. This brought her into touch with the pioneer works of Séguin and Itard, and led her to take courses in experimental psychology. For two years she was the working director of the State orthophrenic school. Her experience and her reading had led to the collection of a great quantity of didactic *matériel,* but, as she found at Bicêtre and elsewhere, admirable *matériel* is of little use, even when used in ways that are technically accurate, unless the spirit of its inventor is present.

The idea of these "tenement nurseries" and of applying the apparatus designed for the mechanical exercise of defective neural apparatus to the education and training of young but normal children occurred to her. The volume before us is a simple and fascinating account of what has been accomplished on these lines. Obviously much more than the transference of the apparatus was involved. It had to be adapted to children in whom the power of self-direction and self-education was present. But the principle of "training the senses," &c., was preserved. It is an interesting reversal of the ordinary tendency which is to apply modified infant school methods to the defective schools, and another instance of the way in which the scientific study of the abnormal may react upon the treatment of the normal. Whether or not Dr. Montessori's methods will lead to a reversion to formal training—none the less soulless because it is derived from modern psychology—is perhaps debateable. That there is some danger of this nobody who knows the schools will be likely to deny.

(3) It is quite impossible to do justice to Prof. Adams's latest contribution to the literature of education within the limits laid down. It is the first volume of a series which is to appear under the general editorship of Sir Henry Jones—"The Schools of Philosophy." The task assigned to Prof. Adams was a supremely difficult one, and we know nobody who could have attempted it with greater chances of success. He had no predecessors in the field upon whose work he might have improved, as he necessarily abandoned the usual methods of presentation employed by historians of educational thought. Instead of a strictly chronological treatment he has given us a broad view of the development of educational concepts—of their interaction, of the recognition of their mutual implications, and of their relation to social and scientific advance. Thus many of the dangers implicit in the study of the history of education are avoided—there is no mistaking the external shell of teaching devices for the spirit and substance of the thought behind them.

It need scarcely be said that Prof. Adams's method occasionally upsets the conventional sense of proportion. Some of the things that we had supposed really mattered are treated with indifference; a new sense of values is introduced. Whether these will bear closer examination remains to be seen, but in any case we may warmly congratulate the author on the successful completion of an arduous undertaking.

J. A. G.

ATOMIC DYNAMICS.

Prinzipien der Atomdynamik. By Prof. J. Stark. I. Teil: "Die elektrischen Quanten." Pp. x + 124. (Leipzig: S. Hirzel, 1910.) Price 3.20 marks. II. Teil: "Die elementare Strahlung." Pp. xv + 286. (Leipzig: S. Hirzel, 1911.) Price 7.80 marks.

IN this work Prof. Stark gives a systematic account of the experimental facts which throw light on the constitution of the atom, and develops a theory of the structure of the atom, mainly on the basis of optical phenomena. The work is divided into three parts. Part i. is intended as an introduction, and deals with our knowledge of the nature and properties of electrons, and of the energy and structure of the electromagnetic field. Little space is devoted to the description of the methods by which the experimental results were obtained, and more prominence is given to the discussion of the validity of the experiments and their value in elucidating the internal structure of the atom.

In chapter iii. the constitution of the atom on Stark's theory is described. It is assumed that electrons and positively charged entities (archions) which are endowed with mass form the constituent parts of an atom. On account of magnetic forces, the archions form a definite configuration in the atom, and cannot be separated without causing its disruption. On the other hand, the electrons which are attached to the archions can be separated without causing the atom to decay. This atomic system, which is more fully developed in part ii., is capable of explaining and systematising many of the experimental facts.

The second part is mainly concerned with electromagnetic radiation. After a discussion of the theoretical principles of radiation, the grouping of spectrum lines into series and the relations existing between the frequencies of the lines are considered. A detailed discussion of line and band spectra and similar phenomena exhibited by Röntgen rays is also given. The archion theory is then worked out more fully, and hypotheses are put forward to account for the origin of spectra. The band spectra are ascribed to the vibrations of the electrons which are attached to the archions, while the archion itself, after losing the electron attached to it, is the elementary oscillator responsible for the line spectrum. The continuous spectrum is ascribed to the vibrations of the free electrons. These by frequent collisions suffer irregular accelerations, and thus give rise to a continuous succession of frequencies. A full and interesting account of the bearing of the author's theory on such problems as the Doppler effect in canal rays, the Zeeman effect, fluorescence, and allied phenomena is given. Also the results obtained with Röntgen and γ-rays are considered in relation to the theory.

The third part, which has not yet appeared, is, according to a statement in the preface, mainly intended for the chemist. It will deal with the structure of the electromagnetic field on the surface of chemical atoms, and with the forces which hold the atoms together in chemical combinations.

A work of this nature, which aims at a discussion of the principles of atomic dynamics, must to a large extent be of a speculative character. In this connection, however, it is important to remember that the work always distinguishes very clearly between experimental facts and speculative theory. Also, the reader who does not agree with the speculations put forward in the work will find in it a very useful record of all researches which contribute to the elucidation of the internal structure of the atom. Perhaps one misses a fuller discussion of radioactive phenomena, which are intimately connected with the problems discussed in this work. Stark's book, which deals with such a fascinating subject in an interesting manner, will prove very useful as a guide to further research.

H. G.

MODERN ROAD CONSTRUCTION.

Modern Road Construction: a Practical Treatise for the Use of Engineers, Students, Members of Local Authorities, &c. By Francis Wood. Pp. xi + 137; illustrated. (London: Charles Griffin and Co., Ltd., 1912.) Price 4*s.* 6*d.* net.

THE conditions relating to the maintenance of roads during the last few years have undergone so much alteration, owing to the introduction of motor vehicles, that the publication of a practical treatise on the subject is fully justified.

The book now under notice cannot fail to be of great service to those having charge of urban roads. The author, who has the supervision of the roads in the Borough of Fulham, appears to have devoted a great deal of attention to observing and recording the wear and tear of different kinds of material used; and in obtaining statistics as to their cost and endurance. The book gives, in a concise, and not too technical a form, the leading characteristics and details of modern road construction, and the results of the traffic to which these roads are subject. The relative merits of macadam, granite sets, asphalt, and wood paving are fully dealt with.

The author considers that macadam on a good foundation, for horse-drawn vehicles, is the best, and the condition of these roads is greatly improved, both as to cleanliness and endurance, when the surface is sprayed with tar; that creosoted soft wood, such as red pine or yellow deal, gives more satisfactory results for urban traffic as regards wear than the harder woods, such as oak or jarrah; that wood paving has the advantage of being silent and not slippery; and that for motor traffic asphalt paving is the best. The relative endurance, and the time the surface will last without replacing, is given as two years for macadam laid on a good foundation; for soft creosoted wood paving laid on concrete, fifteen years; and for rock asphalt on concrete, twenty years.

Statistics are given showing the great advantage that is derived from the use of tar for spraying macadam roads, both in the prevention of dust and by increasing the length of the life of such roads, which the author calculates at 33 per cent. It is also shown that the use of motor vehicles reduces considerably the amount of refuse that has to be removed from the surface of the roads.

The book contains eleven chapters dealing with a general introduction on modern road construction; macadam roads; wear of roads; effect of traffic; tarring macadam roads; methods of using tar and bitumen; rollers and rolling; paving; cost of maintenance of roads; with appendices giving a specification for road-making; wood paving; tarring; and copies of the Road Board specification for pitch.

HISTORICAL GEODESY.

Grandeur et Figure de la Terre. By J. B. J. Delambre. Ouvrage augmenté de notes, de cartes, et publié par les soins de G. Bigourdan. Pp. viii+402. (Paris: Gauthier-Villars, 1912.) Price 15 francs.

"LES conquêtes passent, et ces opérations restent," was the compliment with which Napoleon accepted from Delambre a copy of his "Base du Système métrique décimal." The publication of this work of the great French geodesist offers a good reason why the second half of the above remark was as true as the first. The manuscript which Delambre left unpublished at his death gave an interesting historical account of the pioneer work of the eighteenth century in investigating the size and shape of the earth, and it also reveals the value of his own share in that work. Names well known outside the world of astronomy appear in the book: Colbert gave the first order for a measure of an arc along the meridian of Paris; Robespierre signed a document expelling Lavoisier, Laplace, Coulomb, and Delambre, with others, from the Commission des Poids et Mesures. Many other French names also occur in the book to remind the world how much geodesy owed in its earliest stages to the Académie des Sciences.

The direct effect on contemporary scientific work of such a tremendous upheaval as the French Revolution is well shown in Delambre's account of the delays caused by his repeated arrests at the hands of ignorant provincials. One is tempted to wonder whether, if the metric system had been established at a time when more friendly relations existed between France and England, this country would also have adopted it. M. de Talleyrand's invitation to the British Parliament to appoint a commission of Fellows of the Royal Society to cooperate with members of l'Académie des Sciences in fixing natural and invariable units of weight and length, is still of more than academic interest.

Enough has been said of the historical side of this book. It must now be added that Delambre's accounts of the surveys of arcs in the different parts of the world are marked by very close study of all available sources of information. Where possible, the original manuscripts were studied, and by very acute criticism the faults of much of the earlier work and some of the later work were elucidated. Several investigators, notably J. Cassini, come in for pretty severe treatment; Delambre's critical remarks may still be most useful to warn the young observer as to faults to be avoided. The accounts of the journeys of some of the surveying parties are very interesting, in particular the journal of the Abbé Outhier on the Lapland survey of 1736. Curiously interesting, too, it is to see new items of knowledge gradually entering in as factors in elucidating the problem under discussion. Thus the first emergence of spherical trigonometry and the modification of results owing to the discovery of nutation, come upon the present-day reader with a curious sense of shock.

A debt of gratitude is owing to M. Bigourdan for his work in editing the manuscript. We note only one misprint; Groombridge is spelt wrongly on p. 314. The successful way in which the editing has been done may be taken as a sign of the pleasure that M. Bigourdan has felt in carrying through the undertaking.

OUR BOOKSHELF.

Norse Tales. By Edward Thomas. Pp. 159. (Oxford: The Clarendon Press, 1912.) Price 2s.

This book is a successful attempt to popularise the romance and poetry of ancient Norse literature. Though he has not quite attained the dignity and charm of style which render Sir G. Dasent's "Story of Burnt Njal" and the "Popular Tales" from the collection of Asbjorsen classics in our folk-lore literature, this presentment by Mr. Thomas offers little ground for criticism.

The collection falls into two parts:—first, stories of the gods, a rearrangement of the Prose or Younger Edda, compiled by Snorri Sturleson in the thirteenth century; secondly, an adaptation of the excellent collection of early poetry made by Gudbrand Vigfuson and F. York Powell, under the title of "Corpus Poeticum Boreale." Mr. Thomas, perhaps wisely, does not discuss at length the many problems of the Eddas. All that is certain is that the poems were collected in Iceland, that some bear internal evidence of being older than others, and that they assumed their present shape long after the time of their composition. The land in which they were originally written is still uncertain. The editors of the "Corpus Poeticum Boreale" suggest that some may have their origin in these islands, or may have been re-edited here "at a time when the Irish Church, with her fervent faith, her weird and wild imaginings, and curious half-Eastern legends, was impressing the poetic mind on one side, while the rich and splendid court of Eadgar or Canute would stimulate it on the other."

The introduction by Mr. Thomas is excellent, so far as it goes. But as the book seems to be intended for school use, it might with advantage have been extended, and a bolder attempt might have been made to prepare the student for the assimilation of much that is unfamiliar. We must, however, be thankful for what he has given us: "The Making of the Worlds, of Gods, and of Giants"; the twisting of Loki in the cave which causes earthquakes; the tale of Balder and Loki, where a note might have been added to direct the reader to Prof. Frazer's explanation of the myth; Thor, Helgi, and Sigurd—a splendid feast of poetry and romance.

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.*]

Further Researches into Induced Cell Reproduction and Cancer.

The reviewer of Mr. H. C. Ross's book, "Further Researches into Induced Cell Reproduction and Cancer," vol. ii. (Nature, August 15, page 601), appears to me to have been very unfortunate in saying that "The accuracy of the observations now described depends upon the accuracy of those described before, and they in turn depend upon the accuracy of an equation in which degrees of temperature, minutes of time, and cubic centimetres of solutions are added together." The accuracy of Mr. Ross's observations does not depend in any way upon the equation referred to, which is simply a formula for making a certain jelly. The reviewer would imply that the equation itself is unscientific because degrees of temperature, minutes of time and cubic centimetres of solutions are added together, and that therefore the author does not possess even an elementary knowledge of the subject. The reviewer, however, is himself obviously ignorant of the fact that such an addition is quite scientific and allowable. It is not degrees of temperature and minutes of time which are added together, but the numbers of units of these entities concerned. He might as well criticise any chemical formula, such as H_2O, because such would imply that the hydrogen is multiplied by the oxygen. As a matter of fact, Mr. H. C. Ross's equation was given on my advice, because it is the most suitable way of representing the various factors concerned in the proper concoction of the jelly. The equation represents the differential coefficient of a function of many independent variables, which is the sum of the partial differential coefficients obtained from each variable.

The other remarks of the reviewer show the same want of accuracy. Mr. Ross has proved that human leucocytes can be forced to divide in large numbers by certain agencies, as described by me in Nature of December 14, 1911, No. 2198, p. 231, and it seems to me absurd to maintain that the facts found by him "necessitate the abandonment of every generally accepted belief with regard to mitosis." If the mode of division of human blood leucocytes had been previously determined with certainty, your reviewer's remarks might have been justified; but this is not the case. If Mr. Ross's observations cannot be reconciled with previous hypotheses (which I do not admit), so much the worse for the hypotheses. At all events the leucocytes actually do divide exactly as he has described.

During the last two and a half years Mr. Ross has been subjected to many criticisms of this nature—which criticisms remind me very strongly of the story of Galileo and his critics regarding the satellites of Jupiter. So far as I remember, it is said that the critics denied the possibility of Jupiter having satellites, but at the same time refused to look at them through Galileo's telescope. I think that if some of Mr. Ross's critics would spend as much time over his specimens as I have done they would not be so free with their *a priori* objections.

Ronald Ross.

Johnston Tropical Laboratory, University of Liverpool, August 31.

A Flower-sanctuary.

I beg to thank Mr. Perrycoste for his letter in Nature of September 19. The county of Somerset has for some time had a by-law similar to that of the county of Cornwall; but you will observe that the by-law does not justify the protection of any particular plant, and that the special flora of Cheddar might easily disappear without any violation of its provisions. It only applies to the uprooting or destruction of plants "in such a manner and in such quantities as to damage or disfigure any road," &c., and it is further limited by the proviso which enables persons to collect specimens in small quantities for private and scientific use. I fear that the cases in which a prosecution under such a by-law would succeed are very few, and certainly the by-law falls far short of the realisation of the wish to protect a rare flora.

Edw. Fry.

Fairland, near Bristol, September 21.

William Higgins and the Imponderable Elements.

It is interesting to compare the semi-prophetic speculations of Oersted as so ably stated by Prof. Silvanus Thompson in NATURE of August 29 with a theory put forward by William Higgins in a book published at Dublin in 1814. This work, entitled "Experiments and Observations on the Atomic Theory and Electrical Phenomena," was primarily intended to prove that Dalton's theory had been anticipated by the author in 1789,[1] but some thirty pages in the early part of the book are devoted to a statement of his views on the "imponderable elements."

The following extracts may serve to give some idea of the nature of his surmises:—

"The ultimate particles of ponderable matter are exceedingly minute, but those of imponderable elements, such as caloric, electricity, and light, are so beyond calculation. The utmost stretch of the human mind can no more estimate the size of those particles than it can measure space and duration. However, their divisibility is limited" (p. 24).

"Every ultimate particle of a metal is surrounded with a small although dense atmosphere of caloric, together with a small portion of the electric or some other subtile fluid . . . when two atoms unite, the compound becomes surrounded with one common atmosphere of caloric and rejects a third atom of either of its constituents" (p. 13 *et seq.*).

"When two ultimate particles unite chemically their individuality is destroyed, and they form one solid atom whose capacity is less than its constituents in a detached or simple state, hence it is that caloric is liberated by chemical union. These atoms however retain a sufficient quantity of caloric to furnish them with atmospheres" (p. 20).

"The ultimate particles of different kinds of matter, whether in a solid or gaseous state, do not retain the same quantity of caloric in their respective atmospheres. This probably is occasioned by their different forces of attraction to it. Those particles which attract caloric with most force are surrounded with more of it, in a less space than those particles that attract it with a smaller force" (p. 19).

"Solids also contain a prodigious quantity of caloric, as may be shewn by deflagrating together nitre, brimstone, and crude antimony, reduced to powder, and intimately mixed" (p. 25).

"Caloric and the electric fluid are antagonistic elements, whereas light and caloric seem to be kind and almost constant associates. The light of the sun, and that produced by artificial means, are accompanied by caloric" (p. 40).

Good conductors are those part of the caloric of which is capable of being readily replaced by the electric fluid. "Dry oxides are non-conductors, as their calorific atmospheres are small and strongly attached to their atoms" (p. 43).

The electric spark inflames gunpowder or alcohol owing to "caloric which is disengaged from these substances or from the air in contact with them." Wires are fused by a battery because of "a rapid dislodgement of the specific heat of the metals by the electric matter," and since a wire remains heated during the passage of a current the electric fluid "must also possess the power of urging on, during its passage, through the battery and conductors, a sufficiency of caloric to supply the waste occasioned by the ignition" (p. 26 *et seq.*).

In similar fashion he "explains" the luminosity of meteors, why the electric spark causes combustion between oxygen and hydrogen, and why earthquakes and volcanic eruptions are accompanied by thunder and lightning. The production of heat in Rumford's experiment he admits presents a difficulty, and suggests that it might be due to the displacement of some of the specific heat by electricity, which, it was well known, could be produced by friction. He precedes this by saying that "Heat evolved by friction, however unaccountable and mysterious it may appear, is not sufficient to invalidate the doctrine of the materiality of caloric, being only a solitary fact opposed to thousands that tend to establish its existence as an elementary substance" (p. 37).

He concludes this part of his work with a touch of the true Baconian philosophy:—"The theory, or rather the hypothesis, which I have advanced, on electrical phenomena . . . according to my knowledge is quite new." "So fully convinced am I, at present, of the truth of this doctrine that no vague or superficial objections will be able to stagger my creed; at the same time, I am ready to submit to convincing facts and arguments, for truth should be the sole object of every writer on philosophical subjects" (p. 45 *et seq.*).

It will be seen that his speculations, though crude, and, of course, erroneous in the light of modern theory, are none the less characterised by considerable lucidity in expression and no little ingenuity in application. In this connection we may well remember the words of Liebig: "All our views have been developed from errors." From the flashing embers of fallacy springs the Phœnix of Truth.

A. U. N.

London, W.C., September 1.

[1] See Meldrum, *Chem. News*, 1910, for a discussion of his claims on this point.

Glaciation and Striation.

PROF. COLE (NATURE, September 12, p. 37) would scarcely maintain the assumption that the stones seen in Boulder Clay were in the "englacial" distribution of the materials in closer juxtaposition than we find them in the deposit itself. The tendency of the larger stones to gravitate towards the bottom of the moving and shearing ice-mass through liquefaction and regelation is well illustrated in the Harlow "till." But Prof. Cole seems to forget that a "conglomerate with an ice-cement" would give us a glacial gravel or a "schotter" on the melting of the ice, and not a Boulder Clay. The efficiency as a graving-tool of a grain of quartz or of some harder mineral when caught between the contact-surfaces of two fragments of rock undergoing differential movement can scarcely be doubted.

As to the pre-Boulder Clay age of the "Ipswich man," the evidence of which I have examined on the spot, the attention of Mr. J. R. Moir (*ibid.*, p. 38) and others may be fairly directed to the new light thrown upon the question by the *Thorley* section.

With reference to scratches on flints, I venture to ask Sir Ray Lankester whether in plate 17 of his monograph (Phil. Trans. R.S., Series B, vol. ccii., pp. 203 ff.) he has not overlooked (1) the fact that the striations shown in Fig. 1 are on the original cortex of the flint-nodule, and therefore not necessarily connected with glaciation, and (2) the probability that the markings shown in Fig. 2 (enlarged in Figs. 3, 4, 5) are the etched-out skeletons of some spongoid fossil, by humus acids acting differentially as a solvent on the various modifications of the silica found often in the same flint-nodule? Of such differential solvent action I have a large collection of examples, in some cases showing corrosion to the extent of the complete obliteration of the lithological character of the flint as such.

A. IRVING.

Bishop's Stortford, September 17.

BIRD-MIGRATION.[1]

THIS book has been long expected, and it is certainly one worth waiting for. The author remarks "that no country in the world is more favourably situated than our own for witnessing the movements of migratory birds; that there is none in which the many phases of the phenomenon are of a more varied nature; and none in which the subject has received greater attention." To which we venture to add that no one has made so much use of these opportunities as Mr. Eagle Clarke has done, and that no contribution to the subject compares in importance with the work which is summarised in the book before us. It is, indeed, a striking fact that although the book deals almost wholly with the author's own work, it has a completeness and scope far superior to that of any other book on migration. It represents the spare-time industry of a quarter of a century, a remarkable persistence of observation under difficult conditions on lighthouses, lightships, and lone islands of the sea, a resolute courage in facing and accomplishing the dreary task of analysing the immense masses of data provided by the British Association Committee, and a remarkable restraint in dealing with a fascinating subject which has repeatedly proved itself fatally provocative of romantic treatment. It is scarcely necessary to say that the author has given us from time to time instalments of his results, but here we have a revised and unified presentation of the whole—an achievement calling for the warmest congratulation.

[W. E.

FIG. 1.—Fair Isle: a rift in the western cliffs. From "Studies in Bird Migration."

The plan of the book is simple. After a pleasant chapter on antiquated views (such as the "hibernation" theory, which lasted from Aristotle to Gilbert White and longer) and another—tantalisingly short—on some modern views, the author plunges *in medias res.* He classifies our migratory birds—summer visitors, partial migrants, winter visitors, and birds of passage—gives a summary of the movements of these several groups under their seasons, and indicates in a general way—the only possible way as yet—whence they come to us and whither they go from us. The next chapter, on "The Geographical Aspects of British Bird-Migration," is a masterly account of a very complicated subject, with rather more insistence on definite routes than we have been accustomed to from recent writers. Perhaps a more critical attitude might have been adopted towards the earlier work of Palmen and others.

The next three chapters, which are devoted to "Round the Year among British Migratory Birds," bring out very clearly the contrasts between the spring, autumn and winter movements, and there are two valuable appendices giving the dates of the arrivals and departures of the various species. The last general chapter deals with the vexed

[1] "Studies in Bird Migration." By William Eagle Clarke. Vol. i., pp. xvi+323. Vol. ii., pp. vii+346+25 plates. (London: Gurney and Jackson; Edinburgh: Oliver and Boyd, 1912.) Price 18s. net. 2 vols.

question of "Weather Influences," and is an admirable instance of careful scientific discussion. So much nonsense has been written on this subject that an authoritative statement is doubly welcome; and not only has Mr. Eagle Clarke had the vast data of the British Association Committee to draw upon, but he has secured the valuable cooperation of Dr. W. N. Shaw, Director of the Meteorological Office.

To those who glibly theorise on insufficient data with regard to migrants' supposed preference for "tail-winds," "beam-winds," and such like, we commend what is said on page 173: "The *direction* of the wind has in itself nothing to do with the results described. The winds and the performance, or non-performance, of the migratory movements are the effects of a common cause namely, the particular type of weather prevailing at the time, which may be favourable or unfavourable for the flight of birds to or from our islands." Furthermore we learn that similar conditions—including wind directions—are favourable for a movement both in spring and in autumn, although the direction of the movement is, of course, exactly the opposite at one season to what it is at the other. Thus "south-easterly weather" (a large continental anticyclone to the east of our shores but extending to them, and south-easterly winds in the British area) favours migration across the North Sea in either direction (according to the season), but is unfavourable to intermigration between Britain and Iceland.

The remainder of the book may be divided into two parts. Chapters ix.–xvi. deal in detail with the migrations of eight typical birds—swallow, fieldfare, white-wagtail, song-thrush, skylark, lapwing, starling, and rook. Much of this valuable work is already well known to those who have followed the author's separate papers, but the whole has been thoroughly revised. The second volume and one chapter of the first deal with the author's observations at typical stations round the British coasts the Eddystone Lighthouse (shown on a "bird-night" in a fine frontispiece by Marian Eagle Clarke), the Kentish Knock Lightship, Fair Isle ("the British Heligoland"), St. Kilda, the Flannan Isles, Sule Skerry (west of Orkney), Ushant (where the author was treated as a spy!), and Alderney. An account is given of the movements observed at each station, and what is known in regard to each species of bird is tersely summarised.

It must be clearly understood that this admirable piece of work is not intended as a treatise on bird-migration, summing up all that has been done by various methods in different parts of the world; it is an account of the author's personal observations and inductions. This explains what we cannot help regretting the deliberate condensation and reserve of the second chapter, which is intended as a general introduction for the non-expert, as the majority of zoologists, for instance, must in this connection be called. But even for such as these—the most appreciative of all readers after ornithologists proper—the terseness is surely overdone. Let us illustrate. In the few lines devoted to migration in the southern hemisphere, an important point has surely been obscured in ignoring the great difference between migration in the two hemispheres, that while *many* northern summer birds go far south of the equator to "winter" in the southern summer, only a few petrels and others from the south perform a reverse journey of corresponding extent. Similarly some mention of alternative views on the origin of the migratory habit might well have been given. Again, Mr. Clarke quotes with apparent approval Mr. Chapman's opinion that the recent experimental proof of the homing power of the noddy and sooty terns dispels "the so-called mystery" of how migrants find their way, placing it on a par with "any other instinctive functional activity." But this is an obvious *non sequitur*. Nor does it help matters to describe the special sense of direction (in which Mr. Clarke firmly believes) in Prof. Newton's phrase as "inherited but unconscious experience." An interest-

Photo.] [Dick Peddie.

Fig. 2.—Flannan Islands: Eilean Mor from the east. From "Studies in Bird Migration."

ing point in this chapter is the author's suggestion that night travelling is an adaptation to the necessity that most birds have of devoting the daytime to the seach for food.

The book is lucidly and carefully written and the author occasionally slackens his rein and reveals his power as a stylist, the description of a "bird-night" at Eddystone being perhaps the finest example. There are several good photographs of various stations, notably those of Fair Isle by Mr. W. Norrie, but the chief illustrations are maps and weather-charts—all conspicuous for clearness and simplicity. We have already referred to the admirable first frontispiece. The book is dedicated to the Duchess of Bedford, herself an ardent ornithologist, who has given the author valued assistance.

THE QUESTION OF THE BIPLANE VERSUS *THE MONOPLANE.*

The recent order of the War Office suspending the use of monoplane flying machines for military purposes has led to the renewal, in the daily Press, of a discussion of the old riddle, "Which is the better, the monoplane or the biplane?" When Blériot crossed the Channel, the daily papers rang with the praises of the monoplane; now everyone favours the biplane, and there is a danger lest the monoplane may be condemned for faults not necessarily attributable to the mere fact that it is a monoplane.

The military authorities have wisely called in the assistance of the National Physical Laboratory in seeking an explanation of why so many of the recent accidents have occurred with monoplane machines. Even if the work placed in the hands of the Teddington department does not extend beyond overhauling and testing the machines used in the Army, the physicists ought to have sufficient scope for arriving at many important conclusions regarding essential features of aeroplane construction. For the purposes of an inquiry of the type proposed, it appears desirable that the same tests should be applied to biplanes as to monoplanes; but the value of the work will be greatly enhanced if the investigation is conducted on general lines, and not confined to the mere testing of the Army machines. It is easy enough to say that when a stay has broken it should be replaced by a stronger one, and to draw up a report which would suffice to enable any defects in existing machines to be patched up, but it is essential for real progress that the Laboratory authorities should have a free hand to assist in the evolution of a more perfect type of flying machine than either the existing monoplane or biplane.

It must not be forgotten that the terms monoplane and biplane usually imply something more than the mere difference between a "single-decker" and "double-decker" (to quote the German equivalents). The former usually has the propeller in front, the latter behind. Thus an inquiry necessarily turns on at least two points, namely, the relative advantages of the single- and double-decker, and whether the propeller is better placed in front or behind. Further subjects suggested are the gyrostatic effect of the propellers, the relative merits of rotary and oscillating engines, and so forth.

In regard to the first point, it must be remembered that even Lilienthal experimented successfully with the double-decked type; that Chanute, after trying not only "single-" and "double-decked" gliders, but also "multiple-winged machines," finally decided on the glider with two superposed surfaces as the best on which to experiment; that his experiments were continued by the Wrights, and led to their first realisation of artificial flight. One advantage of the two-surfaced arrangement is that, with an equivalent area, the wings can be made of lesser span, and thus the bending moments they have to sustain are proportionately reduced; moreover, these bending moments are much better sustained by the framework, which naturally takes the form of a latticed girder. Of course, from this point of view a triplane would even be better than a biplane, but the gain would be less important.

There would be no difficulty in constructing a "two-decker" with a propeller in front, and, from the point of view of the physicist, the position of the propeller depends largely on whether it is better for the propeller to receive the wash from the planes or for the planes to receive the wash from the propeller. One advantage of the latter plan has not, perhaps, received the attention that it deserves. It must not be forgotten that the action of the propeller sets up a rotation in the "wash" behind it, and, as Sir G. Greenhill has pointed out, so far from being negligible, the amount of this rotation is directly related to the horse-power and rate of revolution of the engine. In fact, the propeller exerts on the air a constant torque, which tends to produce angular momentum, and is equal in amount to the torque of the engine. If, then, the main planes are placed in the wash of the propeller, the rotating air on striking them will produce a difference of pressure on the two sides tending to counteract the corresponding torque on the aeroplane, and the machine will not heel over sideways to the same extent that it would if a single propeller were placed behind. For the purposes of the War Office, the propeller in front is disadvantageous, as it interferes with scouting or shooting from an aeroplane. On the other hand, we have the recommendation of a well-known engineer that the engine should be in front of the aviator, so that the latter shall not be crushed underneath the former in case of an accident.

Apart from these essential differences between monoplane and biplane, great importance attaches to an investigation into the gyrostatic couples caused by both rotary engines and propellers. At present, apart from setting up strains in the framework, which require the latter to be adequately stayed, these cause a mixing-up of the longitudinal and lateral motions of the machine which must necessarily greatly increase the danger of accidents when the machine is being navigated in gusts of wind. It is important that more attention should be given to the question of balancing, not only of the actual propeller torque by the use of two propellers, but also of the gyrostatic couples due to both the propeller and the rotary engine. Why do not the makers try an engine rotating about a horizontal axis perpendicular to the line of flight, driving a pair of propellers rotating in opposite directions by means of bevelled cogs? The arrangement would be perfectly symmetrical, and the gyrostatic couple of the engine *might* be used to assist in lateral steering.

Another disadvantageous feature of many monoplanes, though not an essential feature of them, is that the wings are usually of considerable breadth, and, of course, are cambered. The result is that when such a machine pitches, effects may occur the nature of which will remain entirely unknown until some experimental knowledge has been obtained regarding air pressures on rotating planes. To assume that these effects are negligible, or even that they may not be the cause of accidents, is, in the circumstances, scarcely justifiable.

It will be interesting to see whether any questions of stability are considered in connection with the present inquiry. The tendency which has existed up to the present time of shelving the problem of inherent stability, and attempting to attribute accidents to other causes, is, after all, very natural. If stability could be ignored altogether, the problem of aviation would be greatly simplified, and much laborious work, both theoretical and experimental, would be saved. Those of us who have spent much time in studying the theory of stability would have been glad to give our attention to other subjects instead, had we believed that a final solution of the problem of flight was possible which should make aviation independent of stability considerations. At the present time, no experimental information exists regarding inherent stability, and a comparison of theory with practice is urgently needed. Under theoretically assumed conditions, stability, both longitudinal and lateral, is greatly affected by variations in the inclination of the flight path to the horizon, and this is a point on which experimental tests would be of particular interest. The fact that so many accidents have occurred the causes of which are unknown shows that aviators have not yet been altogether successful in their attempts to dispense with theories of, and experiments on, stability. The accounts of many accidents are strangely suggestive of what would happen under theoretical conditions if an aeroplane should be flying at an inclination to the horizon consistent with inherent instability.

As regards the monoplane and biplane, these limits are probably very different in existing machines of the two types, but there is no essential difference between the "single-" and "double-decker" in regard to stability. Many monoplanes are of the Antoinette type, and can be made laterally stable by making the tail of sufficient length; many existing biplanes do not possess sufficient auxiliary surfaces for lateral stability, though this defect is probably remedied when the planes are bent up; on the other hand, the auxiliary planes in them are as a rule more favourable to longitudinal stability. These are, however, details of construction which do not depend on whether the machine is a monoplane or biplane. It is probable that most existing aeroplanes satisfy the condition that lateral, like longitudinal, *instability* increases when rising in the air.

It is necessary to repudiate any suggestion that a so-called "theory" of stability (which is really an experimental study of the results of certain assumed hypotheses, the apparatus for which are the methods of mathematical analysis) should be applied to actual aeroplanes without first being subjected to a second experimental test performed with the actual aeroplanes or models of them. But would not even this course be better than continuing to use aeroplanes about the stability of which nothing is known? And admitting that most flights have to be performed in gusty winds, is this any reason for being satisfied with a flying machine which would not fly straight in still air? Some people appear to think so. But is it not probable that the problem of stability presented by an actual aeroplane is more complex and not less complex than that presented by a system of narrow planes moving at small angles through a resisting medium? If this be so, the complexities of the simpler problem may afford some clue to those existing in the more difficult and at present unsolved problem.

It is hoped that no suggestions made in the present article will be regarded as authoritative statements except so far as they may be confirmed by experiments conducted with the aid of mathematical or physical apparatus. If any conclusions are to be drawn from these remarks, they should be to the effect that it is far less important to try to decide whether a biplane is better than a monoplane than to investigate the relative merits of flying machines on a perfectly broad basis. It is, therefore, to be hoped that the staff of the National Physical Laboratory will not only be given a very free hand in the investigations that are placed in their hands, but that they will produce a powerful and thorough report, and—if a small criticism is permissible—give a little more attention to formulating broad general principles, and confine themselves a little less exclusively to the tabulation of minute experimental details than they have done on some previous occasions

G. H. B.

THE INTERNATIONAL METEOROLOGICAL COMMITTEE.

Weather Telegraphy and Maritime Meteorology.

MEETINGS were held in London during the week ending on Friday, September 20, of two Commissions constituted by the International Meteorological Committee to deal with questions concerning international weather telegraphy on the one hand, and with those concerning maritime meteorology and storm warnings on the other. The Commissions were first provisionally appointed at the meeting of the International Committee held in Paris in 1907; they held meetings in London in June, 1909, and upon their report to the meeting of the International Committee held at Berlin in 1910, it was decided to recommend to the meteorological institutes of Europe to substitute a reading of the "barometric tendency" (the change of pressure in the three hours preceding the morning observation) for the reading of the wet-bulb thermometer in the international code. A scheme of storm signals for daylight, using two cones, was also recommended as an international system.

In the telegraphic reports of the morning of May 1, 1911, the change of code recommended was introduced simultaneously by all the countries of Europe, and the "barometric tendency" has now become an important feature of the daily weather message. The recommendation as to storm warnings was hampered by the fact that no agreement could be reached as to the signals that were to take the place of the cones at night.

Having regard to the various incidental questions which remained unsettled, the International Committee at Berlin decided that the two Commissions, which had consisted of only few persons, should be enlarged and become permanent. All the members of the International Committee had therefore been invited to join these Commissions, and also to nominate other persons interested in weather telegraphy and maritime meteorology respectively.

In accordance with the tradition of the International Meteorological Organisation, the administrative work of a commission rests entirely with its president; both the Commissions mentioned are under the presidency of the Director of the Meteorological Office, London, who is also president of the International Meteorological Committee, by which they were appointed. Meetings of the Commissioners were accordingly arranged to be held in London on Tuesday, Wednesday, Thursday, and Friday of the third week in September.

The Board of Education kindly lent the committee-room of the Science Museum for the meetings. The members present were:—For the Commission for weather telegraphy, General Rykatcheff, Director of the Meteorological Service of Russia; Geheimrat Hellmann, Director of the Prussian Meteorological Service, secretary of the International Committee; Prof. Grossmann, representing the Deutsche Seewarte; Prof. Palazzo, Director of the Meteorological and Geodynamic Institute of Rome; M. Angot, Director of the Central Meteorological Bureau of France; Prof. Mohn, Director of the Meteorological Service of Norway; Prof. Van Everdingen, Director of the Meteorological Service of the Netherlands; Captain Ryder, Director of the Meteorological Service of Denmark; Mr. R. G. K. Lempfert, Superintendent of the forecast division of the Meteorological Office. For the Commission for Maritime Meteorology and Storm Warnings there were, in addition, Comandatore Santi, Director of the Hydrographic Bureau of the Royal Italian Marine at Genoa; Dr. van der Stok, Superintendent of Marine Meteorology at de Bilt; and Commander Hepworth, Superintendent of the Marine Division of the Meteorological Office. His Highness the Raj Rana of Jhalawar, and Señor Duarte, chef de service of the Brazilian Meteorological Service, now being reorganised, were invited to attend the meetings of the Commissions.

The representatives of Japan, Dr. Nakamura and Dr. Okada, were prevented from coming by the death of the Emperor. Letters of regret were also received from Prof. Willis Moore, of the United States Weather Bureau; Mr. H. A. Hunt, Commonwealth meteorologist of Australia; Rev. L. Froc, of Zikawei Observatory; Mr. T. F. Claxton, of Hong Kong Observatory; and others.

As regards weather-telegraphy, the questions for discussion grouped themselves into four subjects, which may be mentioned in turn:—

(1) The first was the revision of the international code, incidental to the substitution last year of the "barometric tendency" for the reading to the wet bulb.

After a long discussion agreement was reached whereby two consecutive figure-places can be obtained in the morning groups by using only two figures for the barometric tendency, and also for the air temperature. It is suggested that for ordinary stations one of these places be assigned to the characteristic of the barometric variation in the past three hours, and the other to the direction of motion of the upper clouds; but, in order to encourage the preparation of a daily map of the circulation of the upper air over Europe, it is proposed that for those few international stations where observations of the direction and apparent velocity of clouds can be obtained, the two figures shall be assigned to those elements. For a figure-place incidentally available in the evening groups, the "characteristic of the weather in the past twenty-four hours" is suggested. Figure codes for the four new meteorological "elements" here mentioned were drawn up.

(2) Secondly, the question of the extension and proper organisation of the evening telegraphic weather service was brought forward by the Seewarte, and General Rykatcheff brought before the meeting a project of the Russian service for synchronous observations twice a day over the whole of the Russian Empire, covering 150° of longitude, in cooperation with the service of middle and western Europe.

A schedule of the present hours of observation in all parts of the globe was put forward; and in order to assist these projects it was agreed to recommend 7 a.m., 1 p.m., and 6 p.m. (G.M.T.) as "international hours" for the region between the longitude 30° W. and 30° E., and 6 a.m., 12 noon, and 6 p.m., G.M.T. (8h., 2h., 8h. of St. Petersburg time), as international hours between the longitudes 30° E. and 180° E.

(3) The form of the Iceland telegrams was the third general subject of consideration; and, with reference to that, the Director of the Danish service undertook to give effect as far as possible to any modification that was generally acceptable and that might be regarded as permanent. The opinion of the institutes upon the question will therefore be invited.

(4) The last subject of discussion, mooted by Prof. Willis Moore as a sequel to the deliberations of the recent conference on radiotelegraphy in London, was the notification, to certain centres, of observations at Greenwich noon by all vessels at sea carrying radio-telegraphic apparatus, and the issue of forecasts from the centres to the vessels. The suggestion of organising the distribution of reports by radio-telegraphy on an international plan was welcomed. Some doubt was expressed as to Greenwich noon being the most suitable international hour for the observations, as it would not fit in well with the European system, and some provision for the more general distribution of the information was mentioned as desirable. As the scheme implied legislative action by the various countries, it was decided as a first step to invite the opinions of the various institutes upon the scheme.

The Commission for Maritime Meteorology and Storm Warnings was chiefly concerned with the question of the signals to be used at night to replace the day signals already agreed upon.

Copies of a third edition of the provisional summary of the maritime weather signals at present in use in the various countries of the globe had been prepared for distribution at the meeting.

The various schemes, either at present in operation or advocated on various grounds, group themselves into (1) schemes of three lanterns in the vertical, (2) two lanterns in the vertical, and (3) one lantern only. The scheme of three lanterns was proposed by the Bureau Central Météorologique of France on behalf of the French Ministry of Marine, on the ground that a combination of two lanterns might be confused with signals already adopted in the "regulations for avoiding collisions at sea" or with harbour lights. The Board of Trade approved of these proposals, and undertook to use its good offices to get the harbour lights at two ports where confusion might arise so arranged as to obviate that difficulty. On the other hand, a scheme of two lanterns for gales in the four quadrants, with three lanterns for a hurricane, originally proposed by the Commission in 1909, and objected to first by the Seewarte, and subsequently by others, on account of the liability to confusion, had been tried by the Seewarte on the German coast, and no confusion had arisen; whereas the alternative scheme of three lanterns was pronounced unmanageable, and the hurricane signal was accordingly replaced by one red lamp for an "atmospheric disturbance."

Prof. Willis Moore, to whose initiative the work of the Commission is due, also expressed the opinion that a scheme of three lanterns is unmanageable, and therefore modified the original proposal by proposing two red lamps for a hurricane (instead of one white between two red) and one white lamp for a gale in the north-west quadrant. One red lamp is at present used in some countries to replace any day signal.

In these circumstances it was evident that there was no general agreement in favour of a single scheme of signals, and it was therefore necessary to place the recommendations for the present on the lower plane of agreeing that any combination of lamps forming a storm signal shall have the same significance in whatever country it is used.

The propositions to be submitted to the various institutes will therefore be that, in countries which use three lanterns in the vertical for storm warnings at night, the lanterns shall not be less than two metres apart, and shall be arranged according to the approved scheme of three lanterns; that in countries which use two lanterns, the lanterns shall be not less than two metres apart, generally four metres or fifteen feet, and shall be arranged in accordance with the original proposal of the Commission, with one red lamp to signify an atmospherical disturbance without indication of the direction of the winds instead of three lamps to signify a hurricane; that in countries which use only one lamp for night signals, one red lamp shall replace any of the day signals.

It was agreed to take the opinion of the institutes on a proposal to indicate at a signal-station by a green flag or a green lamp, or otherwise, the information that no warning can be hoisted on account of telegraphic communication being interrupted or for some other cause, as is now done at Thorshavn.

It was also agreed to take the opinion of the institutes upon the desirability of adopting a scheme of international "non-local signals" indicating the position of an atmospheric disturbance, on the lines of the code used at Zikawei and elsewhere on the China coast. Another scheme of day and night signals for a similar purpose, using three cones or three lanterns to indicate the position of a tropical revolving storm, was submitted by Commander Hepworth, and will be circulated also for comments with the report.

Finally the Commission agreed, on the motion of Dr. van der Stok, to recommend the collection of extracts of data from the meteorological logs of ships of all nations for certain ocean squares on the trade routes, with a view to their publication as a contribution to the meteorology of the globe.

The proceedings of the week commenced with a reception by Mrs. Shaw at 10 Moreton Gardens on Monday, September 16. Tuesday, Wednesday, and Friday morning and afternoon, and Thursday morning, were occupied with meetings. Thursday afternoon was set free to enable the reports of proceedings to be prepared in the Meteorological Office. Instead of meeting, the delegates visited Kew Observatory by motor, and took tea in Kew Gardens. In the evening they dined together on the invitation of Dr. Shaw, the President of the International Committee, who was honoured by the presence of the Raj Rana of Jhalawar, and was supported by Sir Norman Lockyer, Sir Charles Watson, Sir George Gibb, the Deputy-Master of Trinity House, the President of the Royal Meteorological Society, Captain Loring, R.N., Captain Sueter, R.N., Captain Clarke, Captain Thomson, C.B., Captain Lyons, R.E., Captain Henrici, R.E., and other representatives of various public offices.

The Raj Rana entertained the members of the Commission at dinner at Bailey's Hotel on Friday, September 20. Some of the delegates remaining in England were entertained for the week-end by Mr. and Mrs. Cave at Ditcham Park, Petersfield.

The reports of the proceedings at the meetings, which were read and signed at the final meetings on Friday, September 20, will now be printed and circulated to the various meteorological institutes for comments. These will be taken into consideration at the next meeting of the International Meteorological Committee, which, it is hoped, may be held in Rome in the week after Easter Week in the year 1913. The meeting will have to consider not only the reports of the Commissions which have already met, but also the important question of the application of meteorology to agriculture, which has been raised by a letter addressed to the president of the International Meteorological Committee by the president of the International Institute for Agriculture, which has its seat at Rome.

Besides the Commissions, the proceedings of which have been referred to here, it may be noted that the Commission for Radiation, under the presidency of Prof. J. Maurer, of Zürich, met in Switzerland in the first week of September; and, earlier in the year—May 27 to June 1—a largely attended meeting of the Commission for Scientific Aëronautics was held at Vienna, under the presidency of Prof. Hergesell. The Commission passed a number of resolutions, one of which, in favour of the establishment of a network of stations for daily observations with pilot balloons, has already been communicated to various Governments through diplomatic channels.

Perhaps the most noteworthy of the resolutions were those passed on the initiative of Prof. Bjerknes, formerly of Christiana, and now of Leipzig, proposing that the results of upper air observations shall be arranged according to definite steps of pressure instead of steps of height; that the heights shall be given in "dynamic" meters—that is, a step corresponding to a certain difference of gravity potential, not of geometrical height; and, thirdly, that pressures shall be recorded in millibars (C.G.S. units) instead of millimetres or inches. These important steps in the direction of arranging the material obtained from the investigation of the upper air in a form suitable for dynamical calculation are to come into effect with January, 1913, but the resolution as to pressure units is to be subject to the approval of the International Meteorological Committee. The forthcoming meeting proposed for Rome is therefore likely to be one of great importance.

SCIENTIFIC COLLECTIONS OF THE GERMAN CENTRAL AFRICA EXPEDITION OF 1907–1908.[1]

IN 1902 the Duke Adolf Friedrich visited East Africa. In 1904 he returned there and explored the region immediately to the south-east of Lake Victoria Nyanza. In 1907 he started again, this time at the head of a well-equipped scientific expedition charged with the special task of examining the volcanic regions west of the Victoria Nyanza and north of Tanganyika. The general results of this 1907–8 expedition have already been published, both in German and in English, the English version having been brought out by Cassell and Co. in 1910. The Duke, after leading his expedition through the countries of Karagwe, Ruanda (including the Kivu district), and the Virunga volcanoes, travelled past Lake Edward Nyanza to the Semliki, the Albert Nyanza, the gold-mines of Kilo, and then westwards through the Ituri Forest and down the Aruwimi to the main Congo, and so back to Germany by the Atlantic Ocean.

The volume before us is the third issued as the result of a careful examination of the immense collections made by this scientific expedition. The two previous volumes have dealt with the topography, geology, and meteorology, and with botany. Vol. iii. gives us, first, a remarkably interesting dissertation on the earth-worms or Oligochæta; on the Serphidæ, Cynipidæ, Chalcididæ, Evaniidæ, and Stephanidæ of hymenopterous insects; on the decapod crustaceans (the land-crabs, shrimps, prawns, &c.) of equatorial Africa; on the bees, the Cladocera, the molluscs (especially land-snails), the bivalves, the burrowing Hymenoptera, and wasps; the birds of the Central African lake region; the ants; the Braconidæ and beetles; the copepods of the East African lake region; the cockroaches and butterflies of Ruwenzori and the Congo Forest. The separate articles have evidently been inserted in the order in which they were written, and have thus been cited here. It would have been more convenient to the zoologist, however, if they had been arranged systematically, so that one passed on, for example, from bees and wasps to ants, or from one group of crustaceans to another, without some intervening description of a totally different group of animals.

Probably the most valuable part of the present compilation will be that on the earth-worms and the birds. Earth-worms—it has long been realised, even by those who do not specialise in any way in that study—are amongst the most interesting and certain means of estimating the relationship between the existing distribution of land and water on the earth's surface and that of past times. The article on the Oligochæta collected by the Adolf-Friedrich Scientific Expedition is accompanied by a well-written summary of the

[1] "Wissenschaftliche Ergebnisse der Deutschen Zentral-Afrika-Expedition, 1907–8," unter Führung Adolf Friedrichs, Herzogs zu Mecklenburg. Band iii., Zoologie i., herausgegeben von Dr. H. Schubotz. Pp. xxiii+560+plates xi–xiv. (Leipzig: Klinkhart and Biermann, 1912.) Price 24 marks.

distribution peculiarities of the earth-worms of Africa and adjoining regions, showing, amongst other things, the intimate faunistic relationships (involving, of course, continuous land surface at one time) between Spain, Syria, and Persia, and again between Sardinia, Sicily, and Tunis; between all equatorial or tropical Africa (Senegambia to Abyssinia and Moçambique), and—it might be added in a lesser degree—Guiana and Brazil; and the very separate and peculiar character, from an earth-worm point of view, of Madagascar and the southern extremity of Africa, both of which constitute very distinct regions in the character of their earth-worms. So far as our knowledge yet extends, the most interesting and richly endowed earth-worm region in Africa is round about Ruwenzori, between the west coast of Victoria Nyanza and the north coast of Tanganyika.

In the article on birds, the survey of all well-known collections is somewhat incomplete, very little reference being made to the reports on the collections made by the writer of this review in Uganda and on Ruwenzori. (In his general summary of the results of the expedition, the Duke Adolf Friedrich attributes the discovery of the Okapi, not to the writer of this review, but to Lieutenant Eriksson; the true facts of the case have been so well stated in M. Jules Fraipont's monograph on the Okapi that it is not necessary to repeat them here.) Several mistakes are made in the spelling of names of non-German authorities and certain place-names. This article, however, like some which have recently appeared in the *Ibis*, emphasises the remarkable beauty and strangeness in coloration of the Central African shrikes (Malaconotus) and the tree hoopoes (Scoptelus). The most striking species of Scoptelus has been named after the Duke Adolf Friedrich.

H. H. Johnston.

NOTES.

Sir W. T. Thiselton-Dyer, K.C.M.G., F.R.S., has been elected an honorary fellow of the Royal Society of South Africa.

A memorial to Lord Lister is to be established at University College Hospital, where Lister was a student. A special committee has been formed under the presidency of the Duke of Bedford, president of the hospital, with Sir John Tweedy, consulting ophthalmic surgeon, as hon. treasurer of the fund. The exact nature of the tribute will be largely decided by the amount of the subscriptions received, but it has been suggested that either a bust or a tablet should be placed in both the hospital and the college. It is understood that the memorial will be local in character, and only those who have been in some way connected with University College or the hospital are being asked to subscribe.

A new case has just been arranged in the Geological Department of the British Museum (Natural History) to illustrate the characteristic coral of each of the successive layers or zones in the Carboniferous Limestone of the Avon Gorge, Bristol, as determined by Dr. Arthur Vaughan. The actual fossils and photographs of the cliff-sections are explained by accompanying diagrams, prepared by Mr. W. D. Lang. It appears that the successive faunas, including the corals, are not directly derived from each other on the spot, but represent a series of migrations. Dr. Vaughan has presented to the museum the whole of the collection of corals on which his well-known researches were based, and this gift has been supplemented by another from Dr. Albert Wilmore, illustrating similar researches undertaken by him in the Carboniferous Limestone of Yorkshire.

The Geological Department of the British Museum (Natural History) has also recently received a valuable gift of Wealden fossils from the Revs. P. Teilhard and F. Pelletier, S.J., who made the collection during a four years' residence near Hastings. A large proportion of the specimens are small teeth from bone-beds which had previously been very little examined, and among them is the unique mammalian tooth described under the name of *Dipriodon valdensis* by Dr. Smith Woodward in 1911. There are numerous teeth of the dwarf crocodile Theriosuchus, which has hitherto been known only from the Purbeck Beds. The series of plant-remains is also important and will shortly be described by Prof. A. C. Seward in a communication to the Geological Society.

Mr. William H. Hogg having been appointed an inspector under the Board of Agriculture for Scotland, the post of resident manager of the Royal Agricultural Society's Experimental Farm at Woburn has become vacant. Applications for the appointment are to be made to the secretary of the society, at 16 Bedford Square, London, W.C., not later than Saturday, November 2.

Prof. Karl Pearson has recently addressed two lectures to the medical profession. One, entitled "Eugenics and Public Health," was delivered at the York Congress of the Royal Sanitary Institute, and the other, "Darwinism, Medical Progress and Eugenics," before the West London Medico-Chirurgical Society as the "Cavendish Lecture." In both the importance of statistical training is insisted on in dealing with the data collected in the Public Health service, and also in deciding the method for their collection. Instances are given of the kind of errors which may be or have been made and can only be avoided by the application of the requisite knowledge and experience. The matter is one of urgent public importance, as social legislation of a kind that is difficult to repeal may be based on conclusions such as Prof. Pearson here criticises in his usual clear and forcible style.

A volume entitled "Problems in Eugenics" (London: The Eugenics Education Society, 1912, pp. 490) contains the majority of the papers read before the recent International Congress in Eugenics, together with translations into English of those which were written in other languages. Such contributions as were sent in too late for inclusion in this volume are to be published in a supplement, which will contain also reports of the discussions and of the speeches delivered at the inaugural banquet. As might be expected, a very wide range of subjects is covered. On one page we read of the inheritance of fecundity in fowls and on another of proposed temperance legislation in Norway. The comparative merits of hectine and salvarsan are set forth by one author, while another discusses the elements which go to make up a successful demagogue. History, anthropology, and experimental psychology have all been drawn on, yet nothing has been included which is not to some extent or in some manner relevant.

During this season's excavations of the Maumbury Rings, Dorchester, the removal of much material from the terrace thrown up during the Civil Wars (1642-43) has disclosed remains of the Roman period, including Samian and other ware of that age, with a brass coin of Constantine. Search was made for indications of tiers of seats, but without result. It must, however, be remarked that according to Valerius Maximus the Senate forbade the erection of such conveniences for public use, although Ovid records that it was Romulus who first arranged seats of turf for the spectators.

The Bureau of American Ethnology announces a forecast of the results of a tour conducted in Argentine territory by Dr. Hrdlicka with the object of studying the remains of early man in that region. In order to ensure the verification of the necessary geological data, he was accompanied by Mr. Bailey Willis, of the U.S. Geological Survey. Unfortunately, the results of this investigation are not in harmony with claims previously made by the discoverers of certain "finds" in South America. The conclusion now reached is unfavourable to the hypothesis of the great antiquity of man in this region, more especially as to the existence of very early predecessors of the Indian in South America; nor does it sustain the theories of the evolution of man in general, or even that of an American race alone, in the southern continent. The facts collected attest only the existence of the already differentiated and relatively modern American Indian. It is not, of course, denied that early man may have existed in South America, but the position taken is that this hypothesis cannot be accepted without much additional scientific evidence. The importance of this announcement in connection with the theories advanced by Prof. Elliot Smith at the recent meeting of the British Association is sufficiently obvious.

In a paper published in the *Archives of the Roentgen Ray*, Dr. Hall-Edwards directs attention to diffusion figures—figures obtained by dropping different coloured dyes in definite amount and regular order on absorbent paper. Very beautiful coloured geometrical figures may thus be produced, four of which are reproduced in a coloured plate, and Dr. Hall-Edwards anticipates that their study may throw some light on the production of patterns in nature.

A technical engineering journal is a somewhat curious place in which to describe new species of mosquitoes, and yet this has been done by Dr. M. N. Tovar in the June issue of the *Revista Tecnica del Ministerio de Obras Publicas*, published at Caracas, Venezuela, in the course of an article on the biting gnats and flies of the Monagas estate, Maturin, such new species being respectively named *Psorophora blanchardi* and *Sabethoides rangeli*. In a second illustrated article in the same issue Dr. L. Alvarado describes certain prehistoric objects from Venezuela.

The fiftieth number of "Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India" contains a preliminary report by Captain W. S. Patton upon his investigations into the etiology of Oriental sore in Cambay. The author concludes that the house-flies (Musca spp.) play no part whatever in the transmission of the disease in Cambay. Although he has failed up to the present to transmit the parasite by the bed-bug, he has "no doubt whatever that the bug *Cimex rotundatus* is the only insect transmitter of the disease' in Cambay, on the ground that the parasite only passes into its flagellate stage in the bug below a certain temperature, and that "this observation exactly coinsides with the geographical distribution of the disease in India." The problem of the transmission of this disease is therefore still without its final solution.

The importation of tuberculosis in frozen meat forms the subject of a short note by Prof. Guido Bordoni-Uffreduzi in the *Rendiconti del R. Istituto lombardo*, xlv., 12. According to this writer something like a scare has occurred in Italy, and exaggerated statements have been circulated to the effect that 90 per cent. of the cattle in the Argentine Republic, whence the beef is obtained, are tuberculous. Prof. Uffreduzi, on the other hand, finds the Argentine cattle to be far less affected by tuberculosis than those bred in Italy; further, he refers to the circumstances (1) that the bacillus occurs rarely in the muscular parts and that only in animals obviously unfit for food; (2) that cooking destroys the bacillus; (3) that adults are not very liable to infection from tuberculosis introduced in the form of food. Hence it is concluded that the danger is more imaginary than real, and is not based on circumstantial evidence.

The need of legislative protection for the Californian so-called valley quail (*Lophortyx californica*) forms the subject of an article by Mr. H. C. Bryant in the July number of *The Condor*. In some districts these birds show a great diminution in number, although in certain areas there is an increase. The provision of sufficient food and proper covert is stated to be necessary.

The Egyptian Gazette of August 1 contains a list of twenty-four species of Sudani mammals and ten of birds living examples of which have been recently received at the Government Zoological Gardens at Giza. The most interesting of these is a white-eared kob antelope (*Cobus leucotis*), from the swamps of the White Nile, believed to be the first example of its kind that has ever left the Sudan alive.

A new species of the minute annelids of the genus Achæta—so called from the absence of bristles—from Armagh is described by the Rev. H. Friend in the

September number of *The Irish Naturalist* as *A. spermatophora*. A second addition to the British fauna is recorded by Mr. N. H. Joy in *The Entomologist's Monthly Magazine* of the same date in the shape of *Orthochaetes insignis*, a beetle common in Brittany.

THE American Camp Fire Club has issued a circular letter setting forth the part played by that body in regard to legislation for the protection of the Pribilow fur-seals. It is claimed that both the recent international fur-seal treaty and the Bill establishing a five-year close season for the fur-seals are the result of action taken by the club. Be this as it may, the enactment of such a close can scarcely fail to be a source of satisfaction in this country. During the Russian occupation of the Pribilows the number of fur-seals was at one time reduced to 31,000, but when the United States came into possession of the islands, after a ten-years' close season, it had increased to nearly five millions. At the present time it is believed that the seal herd does not comprise more than 125,000 head, but it is confidently expected that at the end of the five-years' close season the number will have risen to more than a million.

THE greater part of *Naturen* for July and August is occupied by an illustrated article by Mr. K. E. Schreiner on "the oldest men," in which skulls of the Neanderthal, Spy, and other early races are figured, as well as the lower jaw of *Homo heidelbergensis*, and the skull, teeth, and femur of *Pithecanthropus*, are figured. Genealogical diagrams illustrating different views which have been expressed as to the relationship of the genus last mentioned to the Neanderthal and modern man are of interest. In one case Pithecanthropus is regarded as the direct ancestor of *Homo sapiens*, with *H. neandertaliensis* as the intermediate link; in a second Pithecanthropus and the Neanderthal race are regarded as separate lateral offshoots of the stem which gave rise to the modern races, while in a third Pithecanthropus occupies the same collateral position, but is supposed to have given rise to Neanderthal man, who is accordingly only a distinct cousin of the existing races of mankind.

UNDER the title "An American Lepidostrobus," Prof. J. M. Coulter and Dr. W. J. G. Land have described (*Botanical Gazette*, vol. 51) the first hitherto discovered American coal-measure cone showing the internal structure. Until now American palaeozoic fructifications and seeds have been known only as impressions or casts, in striking contrast to the richness of the coal-measures in Britain and France in petrified remains showing beautifully preserved structure, though the mesozoic formations have yielded a rich harvest of material to American palaeo-botanists such as is unequalled in any other country.

The well-known work of Prof. H. de Vries on the evening primrose, *Oenothera Lamarckiana*, and the various forms (mutants and hybrids) derived from it has been followed up by various cytologists in the hope of elucidating the origin and nature of these forms with reference to the nuclear phenomena. Miss Anne M. Lutz has published an extensive paper (*Biologisches Centralblatt*, 1912, No. 7) based upon the counting of the chromosomes in the dividing nuclei of various Œnotheras, especially in the forms called "triploid mutants"—in which the somatic cells have thrice instead of twice the number of chromosomes normally found in the male and female germ-cells from which the plant arose. The results obtained by Gates, Davis, Geerts, and the writer herself are discussed at length, and considerable ingenuity is shown in the explanation of the various numbers of chromosomes observed in different Œnotheras—a list is given of more than forty possible combinations and permutations in the chromosome numbers in the germ-cells, and the writer claims to have demonstrated "the harmonious relationship existing between practically all of the observed phenomena thus far reported for the germ and somatic cells of *Oenothera*."

PROF. H. E. ARMSTRONG's lecture to the Royal Horticultural Society on "The Stimulation of Plant Growth" is printed in the current number (vol. 38, part 1) of the Society's journal. It is primarily concerned with the action of volatile activating bodies or hormones, which can pass through the membranes of plant cells and stimulate enzymes to set up chemical changes in the cell contents. In the growth of an ordinary green plant two periods may be distinguished —that in which assimilation occurs under the influence of light, and that in which growth takes place at the expense of the materials thus produced. The latter is apparently the period during which stimulation is necessary, that in which enzymes are brought into action as simplifying agents and the products of their action enter into circulation and are carried to the places where they can be used as building materials in promoting growth; probably during this period the membranes become more or less permeable to substances which do not pass them during the period of assimilation. It is pointed out that manures probably act largely as hormones; that ammonia is the most active "natural" stimulant, and that a substance (ammonia, for instance) which is a valuable hormone when used in proportions not exceeding a certain low maximum at once becomes toxic when this maximum is exceeded.

IN the Quarterly Journal of the Geological Society of London for 1912, vol. lxviii., part 2 (price 5*s*.), the president, Prof. W. W. Watts, F.R.S., reviews the important subject of the coal supply of Britain. He urges forcibly that an exploration by boring of concealed coal areas might well be undertaken by the State. The "Summary of Progress of the Geological Survey of Great Britain for 1911" (1912, price 1*s*.) shows how the Coal Measures of the Denbighshire district are being examined, and coal again attracts attention in Staffordshire, Warwickshire, and Scotland (pp. 22, 23, and 46). A second edition has been issued of the Survey's memoir on the country around Cardiff (1912, price 2*s*.), with especial reference to the growth of information as to mines. The memoir on the country around Ollerton, by G. W. Lamplugh and others (price 2*s*.), accompanies sheet

113 of the map (price 1*s.* 6*d.*). Both in the memoir and in the section on the map, the position of the concealed coalfield under Sherwood Forest is well emphasised. Perhaps in anticipation of the comprehensive publication that we expect from the International Geological Congress of 1913, Mr. E. F. Pittman has prepared a handy volume on "The Coal Resources of New South Wales" (Geol. Surv., N.S.W., 1912, price 1*s.*).

THE series of papers on the development of the theories of mathematical logic and the principles of mathematics, by Mr. P. E. B. Jourdain, appearing in *The Quarterly Journal of Pure and Applied Mathematics*, forms a useful contribution to mathematical literature. The sections dealing with Leibniz and Boole appeared some time ago, and we have now received the part (*Quarterly Journal*, No. 171, 1912) dealing with the work of Hugh McColl (1837–1909), Gottlob Frege (born 1848), and Giuseppe Peano. All these sections have been revised, both by the respective authors with whose work they deal and by Mr. Bertrand Russell.

A PAPER contributed to the *Atti dei Lincei*, xxi. (2), 1, by Prof. S. Salaghi bears the title "On the vulgarisation and application of mathematical physics in medicine." It constitutes a plea for the application of hydrodynamical principles to the study of the circulation of the blood, the formulæ for the purpose being the ordinary equations of hydraulics applicable to the motion of liquids in tubes, a subject which the author claims to have introduced into Italy for the first time, but which is now being investigated by Dr. Morandi under the name hæmodynamics.

A SMALL pamphlet on "Rubies," written by Mr. Noel Heaton, has been issued by the Burma Ruby Mines, Ltd. In the course of a few concise paragraphs, Mr. Heaton explains how the natural ruby may be distinguished from other red gem-stones, and especially from the reconstructed and synthetic rubies. The difference in structure between the natural and the artificially prepared stones is clearly brought out by some admirable illustrations. The pamphlet will be found invaluable by jewellers and dealers in precious stones, to whom of late years the identification of rubies has been a troublesome problem. The salient items of the pamphlet are also reprinted in the form of a chart, which may be framed and hung in a convenient position on a wall.

THE Journal of the Institution of Electrical Engineers for July contains a description of a portable instrument for the detection of combustible gases and vapours in air, devised by Messrs. A. Philip and L. J. Steele. It depends on the possibility of causing the gas or vapour to combine with the oxygen of the air by bringing the mixture into contact with a platinum spiral raised to the necessary temperature by the passage of an electric current through it. The combustion thus brought about produces heat which raises the temperature of the platinum spiral still further. The electric current passes through a second spiral identical with the first, but protected from contact with the mixture of gases. By combining the two spirals in any of the well-known ways, the difference of their electrical resistances may be made to indicate the presence of the combustion. In the instrument described, the spirals are in series with the coils of a differential relay, and the redistribution of current which results from the heating of one spiral actuates the relay and a red lamp lights up.

IN the Chemical Society's Journal Prof. Pope and Mr. C. S. Gibson give an account of their successful resolution of *sec*-bitylamine, $C_2H_5.CH(NH_6).CH_3$, a simple substance which had resisted earlier attempts to separate it into two optically-active isomerides. Although the base behaves normally, and its hydrochloride is highly dispersive, a series of sulphonic derivatives were found to produce practically constant rotations in the yellow and green regions of the spectrum. This absence of rotatory dispersion is very exceptional, though some parallel is found in substances such as ethyl tartrate, which show a maximum of specific rotatory power in the yellow or green region of the spectrum.

THE current issue of *Science Progress* contains a second article by Dr. Charles Walker on theories and problems of cancer, and a long article by Dr. F. G. Hopkins on Dr. Pavy and diabetes. Prof. Love contributes an article on tides and the rigidity of the earth, and Mr. J. N. Worthington gives a critical review of the possibilities and limitations of observations of the planet Mars, to be followed in a later article by an account of what these observations have revealed. Chemists will welcome an extremely lucid exposition, by Mr. F. W. Aston, of Sir J. J. Thomson's new method of chemical analysis, which precedes a second article by Mr. D. L. Chapman on conditions of chemical change. Dr. Desch contributes an illustrated article on the structure of metals, Mr. C. T. Gimingham discusses variations in pastures, with special reference to the "fatting" and "non-fatting" pastures of the Romney Marshes, and the "teart" lands of Somersetshire, and Mr. Allan Ferguson gives an historical account of the genesis of logarithms.

THE latest addition to the handy little subject lists issued by the Patent Office, London, W.C., is the subject list of works on horology in the library of the office. The list comprises works on the determination and division of time, dialling, clocks, watches, and other timekeepers.

OUR ASTRONOMICAL COLUMN.

COMET 1912*a* (GALE).—From observations made on September 8, 11, and 15, Dr. Ebell has calculated a set of elements and an ephemeris for comet 1912*a*. The time of perihelion is given as October 4·7088 (Berlin M.T.), and the following is an extract from the ephemeris given in the Kiel Centralstelle Circular, No. 135:—

Ephemeris 12h. (Berlin M.T.)

	R.A.	Decl. S.		R.A.	Decl. S.
	h. m.	° ′		h. m.	° ′
Sept. 27	15 7·3	11 14·8	Sept. 30	15 16·3	7 19·3
,, 28	15 10·5	9 55·2	Oct. 1	15 19·0	6 3·0
,, 29	15 13·4	8 36·7	,, 2	15 21·6	4 48·0

The calculated magnitude for the whole of this period is 5·0, and as the comet sets at about 7 p.m. it is only possible, in these latitudes, to see it low down in the south-west, immediately after sunset. But as the southern declination is decreasing the conditions will become more favourable; also as the comet nears the sun it may brighten intrinsically. Consequently, at the beginning of October, it may become visible about an hour after sunset at an altitude of about 10° above the south-western horizon.

REPORTED METEORIC FALL IN FRANCE.—According to a message transmitted by Reuter's Agency a large and brilliant meteorite fell at two o'clock on Friday morning (September 20), in the department of the Aube, Central France. The report states that the meteorite exploded with such great violence as to shake the neighbouring houses and to cause the residents to believe that an earthquake was occurring.

THE GALACTIC DISTRIBUTION OF CERTAIN STELLAR TYPES.—In a paper appearing in No. 4600 of the *Astronomische Nachrichten*, Dr. Hertzsprung publishes some interesting results concerning the distribution of certain special types of celestial objects in relation to the galaxy.

The seven types considered are shown in the following table, together with the coordinates of the pole of the plane in which each type principally gathers :—

Type	No. of objects	Coordinates, for 1900, of the pole of the favoured plane: Galactic Long.	Galactic Lat.	α	δ
Helium stars Oe_5–B_9	1402	179·2°	+83·0°	182·1	+27·0°
Eclipsing variables...	150	234·0	+87·3	188·2	+25·8
c and *ac* stars	98	243·9	+88·1	189·1	+26·3
Type V., Oa o–Oe o	87	300·0	+88·7	190·7	+26·9
Gaseous nebulæ ...	130	4·2	+87·6	192·7	+28·1
Type IV., N	228	352·6	+86·2	194·2	+27·4
δ Cephei variables ...	60	348·9	+84·6	195·9	+26·8

The data providing these results were taken from vol. lvi. of the Harvard Annals, and Pickering's value, $\alpha=190°$, $\delta=+28°$ (1900), for the position of the galactic pole was used. As will be seen from the results, the type V. stars chiefly lie in a plane nearly coincident with that of the galaxy, while the mean pole for the six other types is practically the same. It should be remarked that the helium stars and those of the fifth type show a tendency to cluster in various galactic longitudes. Thus 72 per cent. of the helium stars lie within 90° of galactic longitude 248°, and 69 per cent. of the fifth type stars lie within 90° of long. 305°, the two positions 248° and 305° being, respectively, the places of greatest density.

RADIO-ACTIVE ELEMENTS IN CELESTIAL BODIES.—Having secured excellent spectrograms of the chromosphere during the Spanish eclipse of 1905, Dr. S. A. Mitchell has compared his (unpublished) wave-lengths with those of Exner and Haschek's radium spectrum, and finds himself unable to confirm Prof. Dyson's suggestion that radium may be present in the chromosphere. As previously noted in these columns, the chromospheric spectrum is probably adequately explained by the presence of other elements. Dr. Mitchell finds no sufficient evidence for the presence of radium emanation and uranium in the chromosphere, and deduces that we must wait for better photographs with greater dispersion than those of Nova Geminorum (2) obtained by Dr. Giebeler before seriously contemplating the presence of these radio-active substances in novæ (*Astronomische Nachrichten*, No. 4600).

THE PHYSICAL CHEMISTRY OF THE LOAF.

THE question of strength in wheaten flour has of late years repeatedly engaged the attention of chemists. Recent researches, more particularly those of Prof. T. B. Wood, have established that strength, or, in other words, the capacity of the flour to give a bold, well-risen loaf, depends in the main on the influence of the electrolytes naturally present on the gluten. The difficulties of the problem have hitherto prevented a more quantitative study of the electrolytes present in flour, but a recent paper from the Carlsberg Laboratory, Copenhagen, by Jessen-Hansen, perhaps marks a first step in this direction. Use is made by him of Sörensen's methods of determining small amounts of acidity, either colorimetrically or by determinations of electrical conductivity, to study the degree of acidity, or, as it is usually termed, the "hydrogen ion concentration" of a number of doughs made in the usual way.

In particular, the effect of the addition of different quantities of acid to the dough was examined, and the acidity compared with the result obtained on baking. The conclusion is drawn that there is a certain optimum concentration of hydrogen ions, in presence of which the best results are obtained on baking; this concentration is rather higher than that of dough prepared from natural flour and distilled water. It differs only slightly according to the quality of the flour, being somewhat higher for the superior grades and rather lower for the lower kinds; it also differs slightly in flour milled from different parts of the berry, being highest for the so-called patents. The optimum concentration corresponds approximately to a hydrogen ion concentration of 10^{-5} normal, pure distilled water being about 10^{-7} normal. It will be obvious that doughs made in this country with the hard alkaline service water must diverge a good deal from this concentration.

Dr. Jessen-Hansen seeks to explain the effect of the various flour improvers which have been brought forward during the last year or so, as due to their increasing the hydrogen ion concentration and not to any subtle working of the improver, as the patentee would sometimes have us believe. Nothing is said, however, to indicate in what way the optimum acidity may be supposed to condition the subtle changes in the gluten which produce a good loaf. It is perhaps significant that the acidity also corresponds to the optimum acidity for protein coagulation.

E. F. A.

AGRICULTURE IN INDIA.[1]

IN his report on the condition of agriculture in India, Mr. Coventry is able to state that the progress recorded in earlier reports has been well maintained, and the beneficent and productive character of the Department's undertakings made much more apparent. Sustained efforts are being made in the cotton tracts to improve the quality and increase the quantity of the staple. In Madras, the improvements have taken two lines—the separation and selection of the best indigenous variety and the introduction of the exotic Cambodia. Similar improvements are also noted in the Central Provinces and Bombay. The well-known work of Mr. and Mrs. Howard on the improvement of Indian wheats is being carried on, and has entered a new phase by the establishment of seed farms where the new varieties can be grown on the large scale for distribution

[1] Report on the Progress of Agriculture in India. (Calcutta, 1912.)
Memoirs of the Department of Agriculture in India. (Pusa.)
The Agricultural Journal of India. (Pusa.)

to the growers. The sugar industry, however, is in a critical condition, the native product failing to compete with sugar from the West, but it is hoped that the industry can be remodelled on scientific lines.

Turning to the memoirs published recently from Pusa, Mr. and Mrs. Howard have succeeded in crossing rust-resistant wheat from northern Europe with some of the native wheats. It was not possible to do this at Pusa, on account of the impossibility of getting the rust-resisting parents to flower in time for crossing to be done and for the resulting grain to ripen before the hot weather set in. The difficulty was overcome by sending the Indian parents to Cambridge for spring sowing, and by carrying out the actual hybridisation work in England. In this way crosses were made between various Indian types and American club and other rust-resistant wheats that promise to be very useful.

In the chemical department Mr. Annett has begun an important study of the date-palm sugar industry, which has hitherto been entirely worked by native methods, involving considerable losses. There can be no doubt of the value of this kind of work; success in putting native industries on a sound foundation would be an achievement of which any department might be proud. The saltpetre industry has already been investigated by Dr. Leather, and we may hope for further good results. Dr. Leather also reports further work on the water requirements of crops.

The Entomological Department has proceeded on its usual lines. Progress has been made with inquiries into the life-histories and habits of injurious insects, amongst the more important being the rhinoceros beetle, the surface and painted grasshoppers, potato bug, lucerne Hypera, small cabbage caterpillar, termites, &c. Steady progress has been made in the preparation and issue of coloured plates illustrative of insect pests of crops, and these have been distributed to various institutions. Useful work has also been done on sericulture.

The Bacteriological Department is now in full work, and may be expected shortly to turn out useful results; whilst the mycologist, the agriculturist, and the cotton specialist are all able to report good work done.

THE BRITISH ASSOCIATION AT DUNDEE. SECTION F.

ECONOMIC SCIENCE AND STATISTICS.

FROM THE OPENING ADDRESS BY SIR HENRY H. CUNYNGHAME, K.C.B., PRESIDENT OF THE SECTION.

HAVING endeavoured to the best of my ability to protest against the idea that economics is not a science, but a mere collection of copybook aphorisms that may be used at random like quack medicines, I should like, with your leave, to endeavour to establish its claim to come among the exact sciences by the surest test that can be applied—namely its capability of being demonstrated by means of geometry and mathematics.

Everyone in this room is no doubt acquainted with the machine known as a barograph or registering barometer. It is constructed as follows: A vertical cylinder covered with white paper revolves once in a week. A light arm is hinged on to a series of hollow elastic circular chambers, from which the air has been pumped out. As the pressure of the atmosphere varies, the air chambers dilate and contract, carrying the arm with them. The arm carries a pen which marks with a dot on the paper the height of the barometer at any time. As the paper moves the dot is drawn out into a line, which gives a continuous record of barometric variations. This diagram is a picture of one of the records.

Now, a little consideration will show what a useful diagram we have here. If we were to attempt to give the information contained in it in words we should have to say something like this. On Monday at 0 a.m. the barometer stood at 28·8 in.; during the morning of Monday it rose until about 2 p.m., when it remained stationary for three hours. It again steadily rose in the evening, until at midnight it stood at 29·9 in. (Fig. 1). On Tuesday it still continued to rise until midday, when it again experienced a fall, &c. Or, if the same results were put into arithmetical form, we should have quite a column of figures.

But this diagram shows us the height of the barometer at any time, and all its fluctuations. Its

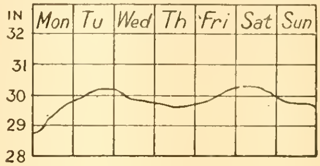

FIG. 1.

life-history for the week and the law of its variations are obvious at a glance, in a way which no words could convey to us. So great are the advantages of this method that barographs are printed in many of the newspapers.

But the use of such curves is not confined to the registration of atmospheric pressure or temperature. They may be used for all purposes. Thus, for example, we might have a curve indicating the variation in successive years of the number of marriages per head of the population.

Line 1 (Fig. 2) shows the proportion of marriages to population from 1870 to 1910. The advantages of this synoptic view are obvious. But they become more obvious still when we add other curves. For instance, line 4 shows the price of wheat in various

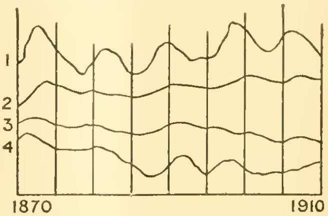

FIG. 2.

years, line 3 the price of coal, line 2 the average of money wages, and line 1 the number of marriages per head of the population. A simple inspection shows that these curves rise and fall sympathetically, and proves beyond doubt that the facts they represent are causally connected.

How eloquently this diagram represents on a space that in a printed book may be three inches square, a series of relations which would take three or four pages to describe even imperfectly in words. And would any description in words enable us to follow the changes like this diagram? The diagram, in fact, plays the part that maps play in geography, and when duly appreciated becomes as valuable as maps of countries.

We may use similar diagrams in the exposition of economic facts. It was, however, reserved for Cournot to show that the use of curves might go further still. Not only might they be used to display statistical facts, but they might also be used to solve problems. I will endeavour to illustrate this very ingenious and interesting development.

It is a well-known fact that in certain departments of industry the cost of making an article increases in proportion to the number produced. The growth of corn is a familiar example of this principle. The principle depends on two facts: (1) that corn can be grown in some places with a less expenditure of capital and labour than in others; and (2) that the quantity of the more favourable land is limited. Whence it follows that growers will first have recourse to the most fertile land; afterwards to that which is

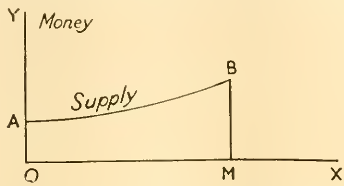

FIG. 3.

less fertile. If we were acquainted exactly with the economics of corn-growing we could represent this state of things in any country at any given time by a curve like a barograph.

Along the line OX (Fig. 3), instead of the progressive days of the week, we should mark off successive quantities of corn, and the vertical height of the curve above any given quality would represent the price per quarter of production of that part which was produced at greatest expense. Thus, the cost of production of the first and most easily grown quarter would be, say 18*s.*, of the next 18*s.* 1*d.*, and so on. And it would be evident that the total cost of the whole of the wheat grown would be obtained by adding all these prices together, that is to say, by the area of the curve OMBA; for an area is but the sum

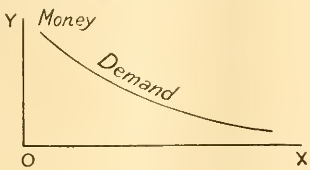

FIG. 4.

of all its constituent parallel lines, just as the total of a bill for goods is an addition of all its items.

Let us now dismiss this corn-growing graph from our minds and turn to another side of the question. Let us consider the various prices which consumers would give for various quantities of corn if they could get these and no more. I do not mean the market prices of the quantities, but what might be called the famine prices, which they would give rather than not have the corn. If we draw a corn-consumers' graph it will obviously be a descending curve, for the more they can get the less they will value successive portions. In fact, if the supply of corn were unlimited the surplus would be used first to feed animals, then to consume as fuel, then as manure, and at last have to be destroyed as a nuisance.

The curve would be of the form shown in Fig. 4.

The contemplation of these curves of corn will no doubt suggest the question whether if we had them we could tell what the market price would be. For it seems obvious that if we know all the conditions, both of demand and supply, we ought to be able to foretell the market price. This is the case and can be easily done. All that is necessary is to superpose the curves, as is done in Fig. 5.

We then see at once that PM must represent the market price of corn per quarter at a given epoch, and OM the quantity produced in a standard time. For if more than OM were grown it could only be sold at a loss; if less the growing of corn would produce an abnormal profit, which would soon cause an expansion, so as to bring the quantity grown and sold up to the maximum that could be profitably produced.

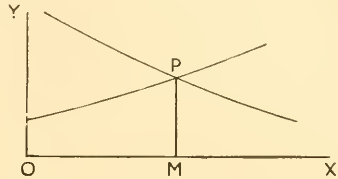

FIG. 5.

These diagrams have therefore done more than present a state of facts; they have solved a problem, just as could be done by a pair of algebraic equations.

Moreover, other illustrations can be derived from Fig. 5. By drawing the series of lines shown in Fig. 6 meanings can be given to various parts of the diagram. The area NPMO represents the total price paid for the corn; the area APMO represents the total cost of growing; the area APN, which is the difference between them, represents the surplus profit obtained from the use of the better lands, or, in other words, rent; the area BPMO represents the total enjoyment the consumer derives from the corn, expressed in terms of money; and since NPMO is the

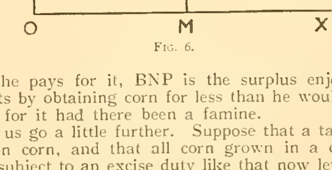

FIG. 6.

price he pays for it, BNP is the surplus enjoyment he gets by obtaining corn for less than he would have given for it had there been a famine.

Let us go a little further. Suppose that a tax were laid on corn, and that all corn grown in a country were subject to an excise duty like that now levied on the manufacture of spirits. Suppose the duty were 5*s.* a quarter, and to simplify the problem suppose no corn came in from the outside. Then the curve APS (Fig. 7) would be pushed upwards all along its length by 5*s.*, and assume a position A'P'S'. And notice that the price would rise, not by 5*s.*, but by some amount rather less than 5*s.* For M'P' – MP must always be less than the upward movement of the curve APS. Again, the rent would be decreased, for the area

N'P'A' is less than NPA. The amount grown would decrease from OM to OM'. The proceeds of the tax would be OM times five shillings, and the consumers' surplus of enjoyment would have considerably diminished. This is all obvious enough if you look at the curves. But I want to ask whether, without a curve, you could have got all that so quickly by logical cogitation? I agree it could have been done by hard thought, but what a help the diagram has been in thinking it out. It is like drawing a genealogical tree when you are thinking out some complex problems of family relationship. A simple inspection of the figure also shows that an *ad valorem* tax on rent would not increase price or diminish production.

Again, what is a monopoly? A monopoly is simply

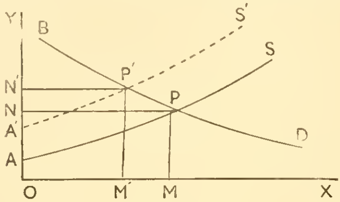

FIG. 7.

a power of stopping production at a point short of that which it would reach under conditions of free production, sale, and distribution. You can stop production by means of statutes regulating quantities produced, or by combinations to limit production, or to limit the supply of labour produced, or by statutes regulating the employment of capital, or by statutes fixing minima of wages, or in various other ways. If you exercise the power, then the state of things shown in Fig. 8 comes into play. The quantity produced is reduced to OM'. The price rises from PM to P'M', the surplus producers' profit (including rent) rises from ANP to AQP'N'. So that profits, interest, and wages increase, but the consumers' surplus enjoyment goes down from NPB to N'P'B. The limitation of output plays a far larger part in the regulation of prices than is commonly supposed. Those who are engaged in the manipulation of the meat trade, and the bread trade, and the petroleum industry, the supply of machinery or other articles, do not usually advertise the means they have taken to limit supply, nor do trade unions publicly descant upon the means they adopt to limit the labour of adults or apprentices. It is no part of our business here to discuss the necessity or the legitimate limits of such limitations. All that I am here to do is to show how useful diagrams are in explaining their effects.

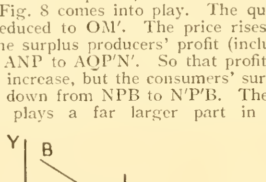

FIG. 8.

The monopoly controller seeks, of course, to make the area AQP'N' a maximum, arranging his price just in the way a milliner would do who had to cut the biggest square she could out of a remnant of material. How much reduction of output and increase of price will the market bear? is the question that all monopolists present to themselves.

I could go on with these curves through a great variety of questions. They become especially interesting where applied to show the effects of tariffs upon export and import trade, but I must forbear.

My principal object has not been to introduce to the notice of the audience a subject already known to many of them, but rather to use it as an illustration of the truth that national economics is subject to laws —laws which, though complicated, are as exact and unfailing as the laws of physics, chemistry, or engineering, and which, if neglected by political engineers, will as certainly bring the State to ruin as the miscalculation of a mechanical engineer in designing a boiler, or of a civil engineer in designing a bridge. Whence, then, instead of consigning economics to Saturn, let us study it, not in a metaphysical or Aristotelian manner, using question-begging epithets, or, on the other hand, in the manner of some moderns, as, for example, Ruskin, by replacing reason by sentiment; but let us approach it in the spirit of positive science.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY PROF. G. ELLIOT SMITH, M.A., M.D., CH.M., F.R.S., PRESIDENT OF THE SECTION.[1]

The Evolution of Man.

AT the outset it is fitting that I should express our sense of the loss this section has sustained in the death of Mr. Andrew Lang. Meeting as we do so near to his home at St. Andrews, it was hoped at one time that his versatile scholarship and literary skill would have been available to add lustre to our deliberations. But early last winter we learned with deep regret that the state of his health would not permit him to accept the presidency of the section. In associating ourselves with those who are deploring the loss literature and history have sustained, we realise that our science also is the poorer to-day through the death of one of its most brilliant expositors.

The Scope of Evolution.

In a recent address Lord Morley referred to "evolution" as "the most overworked word in all the language of the day"; nevertheless, he was constrained to admit that, even when discussing such a theme as history and modern politics, "we cannot do without it." But to us in this section, concerned as we are with the problems of man's nature and the gradual emergence of human structure, customs, and institutions, the facts of evolution form the very fabric the threads of which we are endeavouring to disentangle; and in such studies ideas of evolution find more obvious expression than most of us can detect in modern politics. In such circumstances we are peculiarly liable to the risk of "overworking" not only the word evolution, but also the application of the idea of evolution to the material of our investigations.

My predecessor in the office of president of this section last year uttered a protest against the tendency, to which British anthropologists of the present generation seem to be peculiarly prone, to read evolutionary ideas into many events in man's history and the spread of his knowledge and culture in which careful in-

[1] This report represents the address as it was delivered at the meeting; it is a somewhat condensed and rearranged form of that appearing in the Association's Reports.

vestigation can detect no indubitable trace of any such influences having been at work.

I need offer no apology for repeating and emphasising some of the points brought forward in Dr. Rivers's deeply instructive address; for his lucid and convincing account of the circumstances that had compelled him to change his attitude toward the main problems of the history of human society in Melanesia first brought home to me the fact, which I had not clearly realised until then, that in my own experience, working in a very different domain of anthropology on the opposite side of the world, I had passed through phases precisely analogous to those described so graphically by Dr. Rivers. He told us that in his first attempts to trace out "the evolution of custom and institution" he started from the assumption that "where similarities are found in different parts of the world they are due to independent origin and development, which in turn is ascribed to the fundamental similarity of the workings of the human mind all over the world, so that, given similar conditions, similar customs and institutions will come into existence and develop on the same lines." But as he became more familiar with the materials of his research he found that such an attitude would not admit of an adequate explanation of the facts, and he was forced to confess that he "had ignored considerations arising from racial mixture and the blending of cultures."

I recall these statements to your recollection now, not merely for the purpose of emphasising the far-reaching significance of an address which is certain to be looked back upon as one of the most distinctive and influential utterances from this presidential chair, nor yet with the object of telling you how, in the course of my investigations upon the history of the people in the Nile Valley,[2] I also started out to search for evidences of evolution, but gradually came to realise that the facts of racial admixture and the blending of cultures were far more obtrusive and significant. My intention is rather to investigate the domain of anthropology in which unequivocal evolutionary factors have played a definite rôle; I refer to the study of man's genealogy, and the forces that determined the precise line of development his ancestors pursued and ultimately fashioned man himself.

I suppose it is inevitable in these days that one trained in biological ways of thought should approach the problems of anthropology with the idea of independent development as his guiding principle; but the conviction must be reached sooner or later, by everyone who conscientiously, and with an open mind, seeks to answer most of the questions relating to man's history and achievements—certainly the chapters in that history which come within the scope of the last sixty centuries—that evolution yields a surprisingly small contribution to the solution of the difficulties which present themselves. Most of the factors that call for investigation concerning the history of man and his works are unquestionably the direct effects of migrations and the intermingling of races and cultures.

But I would not have you misunderstand my meaning. Nothing could be further from my intention than to question the reality of evolution, as understood by Charles Darwin, and the tremendous influence it is still exerting upon mankind. In respect of certain perils man may, perhaps, have protected himself from "the general operation of that process of natural selection and survival of the fittest which, up to his appearance, had been the law of the living world" (Sir Ray Lankester); but it has been demonstrated quite definitely that man, in virtue of these very heightened powers, which, to some observers, seem to have secured him an immunity from what Sir Ray Lankester calls "nature's inexorable discipline of death," is constantly exposing himself to new conditions that favour the operations of natural selection, as well as other forms of "selection" which his increased powers of intelligent choice and his subjection to the influences of fashion expose him.

It is not, however, with such contentious matters as the precise mode of operation of evolution at the present day that I propose to deal; nor yet with the discussion of when and how the races of mankind became specialised and differentiated the one from the other. It is the much older story of the origin of man himself and the first glimmerings of human characteristics amidst even the remotest of his ancestors to which I invite you to give some consideration to-day.

In a recently published book[3] the statement is made that "the uncertainties as to man's pedigree and antiquity are still great, and it is undeniably difficult to discover the factors in his emergence and ascent." There is undoubtedly the widest divergence of opinion as to the precise pedigree; nevertheless, there seems to me to be ample evidence now available to justify us sketching the genealogy of man and confidently drawing up his pedigree as far back as Eocene times —a matter of a million years or so—with at least as much certainty of detail and completeness as in the case of any other recent mammal; and if all the factors in his emergence are not yet known, there is one unquestionable, tangible factor that we can seize hold of and examine—the steady and uniform development of the brain along a well-defined course throughout the primates right up to man—which must give us the fundamental reason for "man's emergence and ascent," whatever other factors may contribute toward that consummation.

What I propose to attempt is to put into serial order those vertebrates which we have reason to believe are the nearest relatives to man's ancestors now available for examination, and to determine what outstanding changes in the structure of the cerebral hemispheres have taken place at each upward step that may help to explain the gradual acquirement of the distinctively human mental faculties, which, by immeasurably increasing the power of adaptation to varying circumstances and modifying the process of sexual selection, have made man what he is at present.

The links in the chain of our ancestry supplied by palæontology are few, and of doubtful value, if considered apart from the illumination of comparative anatomy.

Psychologists have formulated certain definite phases through which the evolution of intelligence must have passed in the process of gradual building-up of the structure of the mind. The brain in a sense is the incarnation of this mental structure; and it seemed to me that it would be instructive, and perhaps useful, to employ the facts of the evolution of the brain as the cement to unite into one comprehensive story the accumulations of knowledge concerning the essential facts of man's pedigree, and the factors that have contributed to his emergence, which have been gathered by workers in such diverse departments of knowledge as zoology and comparative anatomy, geology and palæontology, and physiology and psychology.

For it was the evolution of the brain and the ability to profit by experience, which such perfecting of the cerebral mechanism made possible, that led to the emergence of mammals, as I attempted to demonstrate in opening the discussion on the origin of mammals at the Portsmouth meeting last year[4]; and from

[2] "The Ancient Egyptians," Harpers, 1911.

[3] J. A. Thomson and P. Geddes, "Evolution," 1912, p. 102.

[4] Discussion on the "Origin of Mammals" at the meetings of Section D (Brit. Assoc. Reports, 1911, p. 424).

the mammalia, by a continuation of this process of building-up the cerebral cortex, or, if you prefer it, the structure of the mind, was eventually formed that living creature which has attained the most extensive powers of profiting by individual experience.

The study of the brain and mind, therefore, should have been the first care of the investigator of human origins. Charles Darwin, with his usual perspicuity, fully realised this; but since his time the rôle of intelligence and its instruments has been almost wholly ignored in these discussions; or when invoked at all wholly irrelevant aspects of the problems have been considered.

There can be no doubt that this neglect of the evidence which the comparative anatomy of the brain supplies is in large measure due to the discredit cast upon this branch of knowledge by the singularly futile pretensions of some of the foremost anatomists who opposed Darwin's views in the discussions which took place at the meetings of the British Association and elsewhere more than forty years ago.

Many of you no doubt are familiar with Charles Kingsley's delightful ridicule of these learned discussions in the pages of "Water Babies." The controversy excited by Sir Richard Owen's contention that the great distinctive feature of the human brain was the possession of a structure that used to be called the hippocampus minor was not unjustly the mark of his scathing satire.

"The professor had even got up at the British Association and declared that apes had hippopotamus majors in their brains, just as men have. Which was a shocking thing to say; for, if it were so, what would become of the faith, hope, and charity of immortal millions? You may think that there are other more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers, and other little matters of that kind; but that is only a child's fancy, my dear. Nothing is to be depended upon but the great hippopotamus test. If you have a hippopotamus major in your brain you are no ape, though you had four hands, no feet, and were more apeish than the apes of all aperies. Always remember that the one true, certain, final, and all-important difference between you and an ape is that you have a hippopotamus major in your brain and it has none. If a hippopotamus was discovered in an ape's brain, why, it would not be one, you know, but something else."

The measure of the futility of the contention thus held up to scorn can be more justly realised now; for some years ago I discovered that the feature referred to in Kingsley's burlesque phrase, "hippopotamus major," which Owen claimed to be distinctive of the human brain, and Huxley maintained was present also in apes, is quite a primitive characteristic, and the common property of the mammalia in general.

This illustration of the nature of the discussions which distracted attention from the real problems, although the most notorious one, is unfortunately characteristic of the state of affairs that prevailed when prejudice blinded men's eyes to the obvious facts that were calling so urgently for calm investigation.

Man's Pedigree.

No one who is familiar with the anatomy of man and the apes can refuse to admit that no hypothesis other than that of close kinship affords a reasonable or credible explanation of the extraordinarily exact identity of structure that obtains in most parts of the bodies of man and the gorilla. To deny the validity of this evidence of near kinship is tantamount to a confession of the utter uselessness of the facts of comparative anatomy as indications of genetic relationships, and a reversion to the obscurantism of the dark ages of biology. But if anyone still harbours an honest doubt in the face of this overwhelming testimony from mere structure, the reactions of the blood will confirm the teaching of anatomy; and the susceptibility of the anthropoid apes to the infection of human diseases, from which other apes and mammals in general are immune, should complete and clinch the proof for all who are willing to be convinced.

Nor can anyone who, with an open mind, applies similar tests to the gibbon refuse to admit that it is a true, if very primitive, anthropoid ape, nearly related to the common ancestor of man, the gorilla, and the chimpanzee. Moreover, its structure reveals indubitable evidence of its derivation from some primitive Old World or catarrhine monkey akin to the ancestor of the langur, the sacred monkey of India. It is equally certain that the catarrhine apes were derived from some primitive platyrrhine ape, the other, less modified, descendants of which we recognise in the South American monkeys of the present day; and that the common ancestor of all these primates was a lemuroid nearly akin to the curious litle spectral tarsier, which still haunts the forests of Borneo, Java, and the neighbouring islands, and awakens in the minds of the peoples of those lands a superstitious dread—a sort of instinctive horror at the sight of the ghost-like representative of their first primate ancestor.

This much of man's pedigree will, I think, be admitted by the great majority of zoologists who are familiar with the facts; but I believe we can push the line of ancestry still further back, beyond the most primitive primate into Haeckel's suborder Menotyphla, which most zoologists regard as constituting two families of insectivora. I need not stop to give the evidence for this opinion, for most of the data and arguments in support of it have recently been summarised most excellently by Dr. W. K. Gregory.[5]

This group includes the Oriental tree-shrews and the African jumping-shrews. The latter (Macroscelididæ), living in the original South African home of the mammalia, present extraordinarily primitive features linking them by close bonds of affinity to the marsupials. The tree-shrews (Tupaiidæ), however, which range from India to Java, while presenting very definite evidence of kinship to their humble African cousins, also display in the structure of their bodies positive evidence of relationship to the stem of the aristocratic primate phylum.

Quite apart from the striking similarities produced by identical habits and habitats, there are many structural identities in the tree-shrews and lemuroids, not directly associated with such habits, which can be interpreted only as evidences of affinity.

The Neopallium and its Relation to the Ability of Learning by Experience.

Having now sketched the broad lines of man's pedigree right back to the most primitive mammals, let us next consider what were the outstanding factors that determined the course of his ancestors' progressive evolution.

The class mammalia, to which man belongs, is distinguished in structure from all other vertebrates mainly by the size and high development of the brain, and, as regards the behaviour of its members, by the fact that they are able, in immeasurably greater degree than all other animals, not excluding even birds, to profit by individual experience. The behaviour of most, or perhaps it would be more correct to say all, animals, however complex and nicely adapted to their

5 "The Orders of Mammals," Bull. Amer. Mus. Nat. Hist., vol. xxvii., 1910, p. 321.

circumstances it may seem, is essentially instinctive; and the main problem we have to solve, in attempting to explain the emergence of the distinctive attributes of the creature which in greater measure than any other has succeeded in subordinating its instincts to reason, is the means by which it has become possible for the effects of individual experience to be brought to bear upon conduct.

The ability to learn by experience necessarily implies the development, somewhere in the brain, of a something which can act not only as a receptive organ for impressions of the senses and a means for securing that their influence will find expression in modifying behaviour, but also serve in a sense as a recording apparatus for storing such impressions, so that they may be revived in memory at some future time in association with other impressions received simultaneously, the state of consciousness they evoked, and the response they called forth.

Such an organ of associative memory is actually found in the brain of mammals. It is the cortical area to which eleven years ago I applied the term "neopallium."[6] Into it pathways lead from all the sense organs; and each of its territories, which receives a definite kind of impression, visual, acoustic, tactile, or any other, is linked by the most intimate bonds with all the others. In spite of the disapproval of the psychologists, we can indeed regard this neopallium as fulfilling all the conditions of the *sensorium commune*, which Aristotle and many generations of philosophers have sought for twenty centuries; for it is unquestionably a "unitary organ the physical processes of which might be regarded as corresponding to the unity of consciousness" (Wm. MacDougall).

Nothing that happens in this area in the course of its enormous expansion and differentiation in the higher mammals materially affects this fundamental purpose of the neopallium, which continues to remain a unifying organ that acts as a whole, though each part is favourably placed to receive and transmit to the rest its special quota to the sum-total of what we may call the materials of conscious life.

The consciousness which resides, so to speak, in this neopallium, and is fed by the continual stream of sensory impressions pouring into it and awakening memories of past sensations, can express itself directly in the behaviour of the animal through the intermediation of a part of the neopallium itself, the so-called motor area, which is not only kept in intimate relation with the muscles, tendons, and skin by sensory impressions, but controls the voluntary responses of the muscles of the opposite side of the body.

The Differentiation of Mammals and the Effects of Specialisation.

The possession of this higher type of brain enormously widened the scope for the conscious and intelligent adaptation of the animal to varying surroundings; and in the exercise of this newly acquired ability to learn from individual experience, and so appreciate the possibilities of fresh sources of food supply and new modes of life, the way was opened for an infinite series of adaptations to varying environments, entailing structural modifications in which the enhanced plasticity of the new type of animal found expression.

Nature tried innumerable experiments with the new type of brain almost as soon as the humble Therapsid-like mammal felt the impetus of its new-found power of adaptation. In turn, the Prototherian and Metatherian types of brain were tried before the more adaptable scheme of the Eutherian brain was evolved.

[6] "The Natural Subdivision of the Cerebral Hemisphere," *Journ. Anat. and Phys.*, vol. xxxv., 1901, p. 431; Arris and Gale Lectures on the Evolution of the Brain, *Lancet*, January 15, 1910, p. 153.

The new breed of intelligent creatures rapidly spread from their South African home throughout the whole world, and exploited every mode of livelihood. The power of adaptation to the particular kind of life each group chose to pursue soon came to be expressed in a bewildering variety of specialisations in structure, some for living on the earth or burrowing in it, others for living in trees or even for flight; others, again, for an aquatic existence. Some mammals became fleet of foot, and developed limbs specially adapted to enhance their powers of rapid movement. They attained an early pre-eminence, and were able to grow to large dimensions in the slow-moving world at the dawn of the age of mammals. Others developed limbs specially adapted for swift attack and habits of stealth, successfully to prey upon their defenceless relatives.

Most of these groups attained the immediate success that often follows upon early specialisation; but they also paid the inevitable penalty. They became definitely committed to one particular kind of life; and in so doing they had sacrificed their primitive simplicity and plasticity of structure, and in great measure their adaptability to new conditions. The retention of primitive characters, which so many writers upon biological subjects, and especially upon anthropology, assume to be a sign of degradation, is not really an indication of lowliness. We should rather look upon high specialisation of limbs and the narrowing of the manner of living to one particular groove as confessions of weakness, the renunciation of the wider life for one that is sharply circumscribed.

The stock from which man eventually emerged played a very humble rôle for long ages after many other mammalian orders had waxed great and strong. But the race is not always to the swift, and the lowly group of mammals which took advantage of its insignificance to develop its powers evenly and very gradually, without sacrificing in narrow specialisation any of its possibilities of future achievement, eventually gave birth to the dominant and most intelligent of all living creatures.

The tree-shrews are small squirrel-like animals which feed on "insects and fruit, which they usually seek in trees, but also occasionally on the ground. When feeding they often sit on their haunches, holding the food, after the manner of squirrels, in their forepaws."[7] They are of "lively disposition and great agility."[8] These vivacious, large-brained little insectivores, linked by manifold bonds of relationship to some of the lowliest and most primitive mammals, present in the structure of their skull, teeth, and limbs undoubted evidence of a kinship, remote though none the less sure, with their compatriots the Malaysian lemurs; and it is singularly fortunate for us in this inquiry that side by side there should have been preserved from the remote Eocene times, and possibly earlier still, these insectivores, which had almost become primates, and a little primitive lemuroid, the spectral tarsier, which had only just assumed the characters of the primate stock, when nature fixed their types and preserved them throughout the ages, with relatively slight change, for us to study at the present day.

Thus we are able to investigate the influence of an arboreal mode of life in stimulating the progressive development of a primitive mammal, and to appreciate precisely what changes were necessary to convert the lively, agile Ptilocercus-like ancestor of the primates into a real primate.

In the forerunners of the mammalia the cerebral hemisphere was predominantly olfactory in function; and even when the true mammal emerged, and all the

[7] Flower and Lydekker, "Mammals, Living and Extinct," 1891, p. 618.
[8] W. K. Gregory, *op. cit.*, p. 260, and pp. 279, 28 .

other senses received due representation in the neopallium, the animal's behaviour was still influenced to a much greater extent by smell impressions than by those of the other senses.

This was due not only to the fact that the sense of smell had already installed its instruments in, and taken firm possession of, the cerebral hemisphere long before the advent in this dominant part of the brain of any adequate representation of the other senses, but also, and chiefly, because to a small land-grubbing animal the guidance of smell impressions, whether in the search for food or as a means of recognition of friends or enemies, was much more serviceable than all the other senses. Thus the small creature's mental life was lived essentially in an atmosphere of odours, and every object in the outside world was judged primarily and predominantly by its smell; the senses of touch, vision, and hearing were merely auxiliary to the compelling influence of smell.

Once such a creature left the solid earth and took to an arboreal life all this was changed, for away from the ground the guidance of the olfactory sense lost much of its usefulness. Life amidst the branches of trees limits the usefulness of olfactory organs, but it is favourable to the high development of vision, touch, and hearing. Moreover, it demands an agility and quickness of movement that necessitates an efficient motor cortex to control and co-ordinate such actions as an arboreal mode of life demands (and secures, by the survival only of those so fitted), and also a well-developed muscular sensibility to enable such acts to be carried out with precision and quickness. In the struggle for existence, therefore, all arboreal mammals, such as the tree-shrews, suffer a marked diminution of their olfactory apparatus, and develop a considerable neopallium, in which relatively large areas are given up to visual, tactile, acoustic, kinæsthetic, and motor functions, as well as to the purpose of providing a mechanism for mutually blending in consciousness the effects of the impressions pouring in through the avenues of these senses.

Thus a more equable balance of the representation of the senses is brought about in the large brain of the arboreal animal; and its mode of life encourages and makes indispensable the acquisition of agility. Moreover, these modifications do not interfere with the primitive characters of limb and body. These small arboreal creatures were thus free to develop their brains and maintain all the plasticity of a generalised structure, which eventually enabled them to go far in the process of adaptation to almost any circumstances that presented themselves.

Amongst the members of this group, as in all the other mammalian phyla, the potency of the forces of natural selection was immensely enhanced by the fact that the inquisitiveness of an animal which can learn by experience, *i.e.*, is endowed with intelligence, was leading these plastic insectivores into all kinds of situations which were favourable for the operation of selection. Various members of the group became specialised in different ways. Of such specialised strains the one of chief interest to us is that in which the sense of vision became especially sharpened.

The Origin of Primates.

Towards the close of the Cretaceous period some small arboreal shrew-like creature took another step in advance, which was fraught with the most far-reaching consequences; for it marked the birth of the primates and the definite branching off from the other mammals of the line of man's ancestry.

A noteworthy further reduction in the size of the olfactory parts of the brain, such as is seen in that of Tarsius,[9] quite emancipated the creature from the dominating influence of olfactory impressions, the sway of which was already shaken, but not quite overcome, when its tupaioid ancestor took to an arboreal life. This change was associated with an enormous development of the visual cortex in the neopallium, which not only increased in extent so as far to exceed that of Tupaia, but also became more highly specialised in structure. Thus, in the primitive primate, vision entirely usurped the controlling place once occupied by smell; but the significance of this change is not to be measured merely as the substitution of one sense for another. The visual area of cortex, unlike the olfactory, is part of the neopallium, and when its importance thus became enhanced the whole of the neopallium felt the influence of the changed conditions. The sense of touch also shared in the effects, for tactile impressions and the related kinæsthetic sensibility, the importance of which to an agile tree-living animal is obvious, assist vision in the conscious appreciation of the nature and the various properties of the things seen, and in learning to perform agile actions which are guided by vision.

An arboreal life also added to the importance of the sense of hearing; and the cortical representation of this sense exhibits a noteworthy increase in the primates, the significance of which it would be difficult to exaggerate in the later stages, when the simian are giving place to the distinctively human characteristics.

The high specialisation of the sense of sight awakened in the creature the curiosity to examine the objects around it with closer minuteness, and supplied guidance to the hands in executing more precise and more skilled movements than the tree-shrew attempts. Such habits not only tended to develop the motor cortex itself, trained the tactile and kinæsthetic senses, and linked up their cortical areas in bonds of more intimate associations with the visual cortex, but they stimulated the process of specialisation within or alongside the motor cortex of a mechanism for regulating the action of that cortex itself—an organ of attention which co-ordinated the activities of the whole neopallium so as the more efficiently to regulate the various centres controlling the muscles of the whole body. In this way not only is the guidance of all the senses secured, but the way is opened for all the muscles of the body to act harmoniously so as to permit the concentration of their action for the performance at one moment of some delicate and finely adjusted movement.

In some such way as this there was evolved from the motor area itself, in the form of an outgrowth placed at first immediately in front of it, a formation, which attains much larger dimensions and a more pronounced specialisation of structure in the primates than in any other order; it is the germ of that great prefrontal area of the human brain which is said to be "concerned with attention and the general orderly co-ordination of psychic processes,"[10] and as such is, in far greater measure than any other part of the brain, deserving of being regarded as the seat of the higher mental faculties and the crowning glory and distinction of the human fabric.

[By means of lantern slides representing Dr. Scharff's convincing elucidation of the modifications of the land connections during Tertiary times, a demonstration was given of the wanderings of the primates, which the facts of palæontology and comparative anatomy demand; the object being to direct attention to the fact

9 "On the Morphology of the Brain in the Mammalia, with Special Reference to that of the Lemurs, Recent and Extinct," Trans. Linn. Soc. Lond., second series; *Zoology*, vol. viii., Part 10, February, 1903.

10 J. S. Bolton "The Functions of the Frontal Lobes," *Brain*, 1903.

that at each stage in the migrations of man's ancestors, menotyphlous, prosimian, platyrrhine, catarrhine and anthropoid, the unprogressive members remained somewhere in the neighbourhood of the home of their immediate ancestors, and that those which wandered into new surroundings had to struggle for their footing, and as the result of this striving attained a higher rank.

Other slides were shown to demonstrate the fact that in this series of primates there was a steady development of the brain—expansion and differentiation of the visual, tactile and auditory centres, and development of the meeting territory between them; a marked growth and specialisation of the motor centres, and the power of skilled movements, especially of the hands and fingers; and a regular expansion of the prefrontal area—along the lines marked out once for all when the first primate was formed from some menotyphlous progenitor.]

Thus the outstanding feature in the gradual evolution of the primate brain is a steady growth and differentiation of precisely those cortical areas which took on an enhanced importance in the earliest primates.

So far in this address I have been delving into the extremely remote, rather than the nearer, ancestry of man, because I believe the germs of his intellectual preeminence were sown at the very dawn of the Tertiary period, when the first anaptomorphid began to rely upon vision rather than smell as its guiding sense. In all the succeeding ages since that remote time the fuller cultivation of the means of profiting by experience, which the tarsioid had adopted, led to the steady upward progression of the primates. From time to time many individuals, finding themselves amidst surroundings which were thoroughly congenial and called for no effort, lagged behind; and in Tarsius and the lemurs, the New World monkeys, the Old World monkeys, and the anthropoids, not to mention the extinct forms, we find preserved a series of these laggards which have turned aside from the highway which led to man's estate.

The primates at first were a small and humble folk, who led a quite unobtrusive and safe life in the branches of trees, taking small part in the fierce competition for size and supremacy that was being waged upon the earth beneath them by their carnivorous, ungulate, and other brethren. But all the time they were cultivating that equable development of all their senses and limbs, and that special development of the more intellectually useful faculties of the mind which, in the long run, were to make them the progenitors of the dominant mammal—the mammal which was to obtain the supremacy over all others, while still retaining much of the primitive structure of limb that his competitors had sacrificed. It is important, then, to keep in mind that the retention of primitive characters is often to be looked upon as a token that their possessor has not been compelled to turn aside from the straight path and adopt protective specialisations, but has been able to preserve some of his primitiveness and the plasticity associated with it, precisely because he has not succumbed or fallen away in the struggle for supremacy. It is the wider triumph of the individual who specialises late, after benefiting by the many-sided experience of early life, over him who in youth becomes tied to one narrow calling.

In many respects man retains more of the primitive characteristics, for example, in his hands, than his nearest simian relatives; and in the supreme race of mankind many traits, such as abundance of hair, persist to suggest pithecoid affinities, which have been lost by the more specialised negro and other races. Those anthropologists who use the retention of primitive features in the Nordic European as an argument to exalt the negro to equality with him are neglecting the clear teaching of comparative anatomy, that the persistence of primitive traits is often a sign of strength rather than of weakness. This factor runs through the history of the whole animal kingdom.[11] Man is the ultimate product of that line of ancestry which was never compelled to turn aside and adopt protective specialisation either of structure or mode of life, which would be fatal to its plasticity and power of further development.

Having now examined the nature of the factors that have made a primate from an insectivore and have transformed a tarsioid prosimian into an ape, let us turn next to consider how man himself was fashioned.

The Origin of Man.

It is the last stage in the evolution of man that has always excited chief interest and has been the subject of much speculation, as the addresses of my predecessors in this presidency bear ample witness.

These discussions usually resolve themselves into the consideration of such questions as whether it was the growth of the brain, the acquisition of the power of speech, or the assumption of the erect attitude that came first and made the ape into a human being. The case for the erect attitude was ably put before the Association in the address delivered to this section by Dr. Munro in 1893. He argued that the liberation of the hands and the cultivation of their skill lay at the root of man's mental supremacy.

If the erect attitude is to explain all, why did not the gibbon become a man in Miocene times? The whole of my argument has aimed at demonstrating that the steady growth and specialisation of the brain has been the fundamental factor in leading man's ancestors step by step right upward from the lowly insectivore status, nay, further, through every earlier phase in the evolution of mammals—for man's brain represents the consummation of pr c!s-ly those factors which throughout the vertebrata have brought their possessors to the crest of the wave of progress. But such advances as the assumption of the erect attitude are brought about simply because the brain has made skilled movements of the hands possible and of definite use in the struggle for existence: yet once such a stage has been attained the very act of liberating the hands for the performance of more delicate movements opens the way for a further advance in brain development to make the most of the more favourable conditions and the greater potentialities of the hands.

It is a fact beyond dispute that the divergent specialisation of the human limbs, one pair for progression, and the other for prehension and the more delicately adjusted skilled action, has played a large part in preparing the way for the emergence of the distinctively human characteristics; but it would be a fatal mistake unduly to magnify the influence of these developments. The most primitive living primate, the spectral tarsier, frequently assumes the erect attitude, and uses its hands for prehension rather than progression in many of its acts, and many other lemurs, such as the Indrisinæ of Madagascar, can and do walk erect.

In the remote Oligocene, a catarrhine ape, nearly akin to the ancestors of the Indian sacred monkey, Semnopithecus, became definitely specialised in structure in adaptation for the assumption of the erect attitude; and this type of early anthropoid has persisted with relatively slight modifications in the gibbon of the present day. But if the earliest gibbons were already able to walk upright, how is it, one might ask, that they did not begin to use their hands, thus freed from the work of progression on the earth, for skilled work, and at once before men? The

[11] "The Brain in the Edentata," Trans. Linn. Soc., 1899.

obvious reason is that the brain had not yet attained a sufficiently high stage of development to provide a sufficient amount of useful skilled work, apart from the tree-climbing, for these competent hands to do.

The ape is tied down absolutely to his experience, and has only a very limited ability to anticipate the results even of relatively simple actions, because so large a proportion of his neopallium is under the dominating influence of the senses.

Without a fuller appreciation of the consequences of its actions than the gibbon is capable of, the animal is not competent to make the fullest use of the skill it undoubtedly possesses. What is implied in acquiring this fuller appreciation of the meaning of events taking place around the animal? The state of consciousness awakened by a simple sensory stimulation is not merely an appreciation of the physical properties of the object that supplies the stimulus: the object simply serves to bring to consciousness the results of experience of similar or contrasted stimulations in the past, as well as the feelings aroused by or associated with them, and the acts such feelings excited. This mental enrichment of a mere sensation so that it acquires a very precise and complex meaning is possible only because the individual has this extensive experience to fall back upon; and the faculty of acquiring such experience implies the possession of large neopallial areas for recording, so to speak, these sensation-factors and the feelings associated with them. The "meaning" which each creature can attach to a sensory impression presumably depends, not on its experience only, but more especially upon the neopallial provision in its brain for recording the fruits of such experience.

Judged by this standard, the human brain bears ample witness, in the expansion of the great temporo-parietal area, which so obviously has been evolved from the regions into which visual, auditory, and tactile impulses are poured, to the perfection of the physical counterpart of the enrichment of mental structure, which is the fundamental characteristic of the human mind.

The second factor that came into operation in the evolution of the human brain is merely the culmination of a process which has been steadily advancing throughout the primates: I refer to the high state of perfection of the cortical regulation of skilled movements, many of which are acquired by each individual in response to a compelling instinct that forces every normal human being to work out his own salvation by perpetually striving to acquire such manual dexterity.

This brings us to the consideration of the nature of the factors that have led to the wide differentiation of man from the gorilla. Why is it that these two primates, structurally so similar and derived simultaneously from common parents, should have become separated by such an enormous chasm, so far as their mental abilities are concerned?

There can be no doubt that this process of differentiation is of the same nature as those which led one branch of the Eocene tarsioids to become monkeys while the other remained prosimiæ; advanced one group of primitive monkeys to the catarrhine status, while the rest remained platyrrhine; and converted one division of the Old World apes into anthropoids, while the others retained their old status. Put into this form as an obvious truism, the conclusion is suggested that the changes which have taken place in the brain to convert an ape into man are of the same nature as, and may be looked upon merely as a continuation of, those processes of evolution which we have been examining in the lowlier members of the primate series. It was not the adoption of the erect attitude or the invention of articulate language that made man from an ape, but the gradual perfecting of the brain and the slow upbuilding of the mental structure, of which erectness of carriage and speech are some of the incidental manifestations.

The ability to perform skilled movements is conducive to a marked enrichment of the mind's structure and the high development of the neopallium, which is the material expression of that enrichment. There are several reasons why this should be so. The mere process of learning to execute any act of skill necessarily involves the cultivation, not only of the muscles which produce the movement, and the cortical area which excites the actions of these muscles, but in even greater measure the sensory mechanisms in the neopallium which are receiving impressions from the skin, the muscles, and the eyes, to control the movements at the moment, and incidentally are educating these cortical areas, stimulating their growth, and enriching the mental structure with new elements of experience. Out of the experience gained in constantly performing acts of skill, the knowledge of cause and effect is eventually acquired. Thus the high specialisation of the motor area, which made complicated actions possible, and the great expansion of the temporo-parietal area, which enabled the ape-man to realise the "meaning" of events occurring around it, reacted one upon the other, so that the creature came to understand that a particular act would entail certain consequences. In other words, it gradually acquired the faculty of shaping its conduct in anticipation of results.

Long ages ago, possibly in the Miocene, the ancestors common to man, the gorilla, and the chimpanzee became separated into groups, and the different conditions to which they became exposed after they parted company were in the main responsible for the contrasts in their fate. In one group the distinctively primate process of growth and specialisation of the brain, which had been going on in their ancestors for many thousands, even millions, of years, reached a stage when the more venturesome members of the group, stimulated perhaps by some local failure of the customary food, or maybe led forth by a curiosity bred of their growing realisation of the possibilities of the unknown world beyond the trees which hitherto had been their home, were impelled to issue forth from their forests, and seek new sources of food and new surroundings on hill and plain, wherever they could obtain the sustenance they needed. The other group, perhaps because they happened to be more favourably situated or attuned to their surroundings, living in a land of plenty which encouraged indolence in habit and stagnation of effort and growth, were free from this glorious unrest, and remained apes, continuing to lead very much the same kind of life (as gorillas and chimpanzees) as their ancestors had been living since the Miocene or even earlier times. That both of these unenterprising relatives of man happen to live in the forests of tropical Africa has always seemed to me to be a strong argument in favour of Darwin's view that Africa was the original home of the first creatures definitely committed to the human career; for while man was evolved amidst the strife with adverse conditions, the ancestors of the gorilla and chimpanzee gave up the struggle for mental supremacy simply because they were satisfied with their circumstances; and it is more likely than not that they did not change their habitat.

The erect attitude, infinitely more ancient than man himself, is not the real cause of man's emergence from the simian stage; but it is one of the factors made use of by the expanding brain as a prop still further to extend its growing dominion, and by fixing and establishing in a more decided way this erectness it liberated the hand to become the chief instrument of man's further progress.

In learning to execute movements of a degree of delicacy and precision to which no ape could ever attain, and the primitive ape-man could only attempt once his arm was completely emancipated from the necessity of being an instrument of progression, that cortical area which seemed to serve for the phenomena of attention became enhanced in importance. Hence the prefrontal region, where the activities of the cortex as a whole are, as it were, focussed and regulated, began to grow until eventually it became the most distinctive characteristic of the human brain, gradually filling out the front of the cranium and producing the distinctively human forehead. In the diminutive prefrontal area of Pithecanthropus,[12] and to a less marked degree, Neanderthal man,[13] we see illustrations of lower human types, bearing the impress of their lowly state in receding foreheads and great brow ridges. However large the brain may be in *Homo primigenius,* his small prefrontal region, if we accept Boule and Anthony's statements, is sufficient evidence of his lowly state of intelligence and reason for his failure in the competition with the rest of mankind.

The growth in intelligence and in the powers of discrimination no doubt led to a definite cultivation of the æsthetic sense, which, operating through sexual selection, brought about a gradual refinement of the features, added grace to the general build of the body, and demolished the greater part of its hairy covering. It also led to an intensification of the sexual distinctions, especially by developing in the female localised deposits of fatty tissue, not found in the apes, which produced profound alterations in the general form of the body.

Right-handedness.

To one who considers what precisely it means to fix the attention and attempt the performance of some delicately adjusted and precise action it must be evident that one hand only can be usefully employed in executing the consciously skilled part in any given movement. The other hand, like the rest of the muscles of the whole body, can be only auxiliary to it, assisting, under the influence of attention, either passively or actively, in steadying the body or helping the dominant hand. Moreover, it is clear that if one hand is constantly employed for doing the more skilled work, it will learn to perform it more precisely and more successfully than either would if both were trained, in spite of what ambidextral enthusiasts may say. Hence it happened that when nature was fashioning man the forces of natural selection made one hand more apt to perform skilled movements than the other. Why precisely it was the right hand that was chosen in the majority of mankind we do not know, though scores of anatomists and others are ready with explanations. But probably some slight mechanical advantage in the circumstances of the limb, or perhaps even some factor affecting the motor area of the left side of the brain that controls its movements, may have inclined the balance in favour of the right arm; and the forces of heredity have continued to perpetuate a tendency long ago imprinted in man's structure when first he became human.

The fact that a certain proportion of mankind is left-handed, and that such a tendency is transmitted to some only of the descendants of a left-handed person, might perhaps suggest that one half of mankind was originally left-handed and the other right-handed, and that the former condition was recessive in the Mendelian sense, or that some infinitesimal advantage may have accrued to the right-handed part of the original community, which in time of stress spared them in preference to left-handed individuals; but the whole problem of why right-handedness should be much more common than left-handedness is still quite obscure. The superiority of one hand is as old as mankind, and is one of the factors incidental to the evolution of man.

It is easily comprehensible why one hand should become more expert than the other, as I have attempted to show; and the fact remains that it is the right hand, controlled by the left cerebral hemisphere, which is specially favoured in this respect. This heightened educability of the (left) motor centre (for the right hand) has an important influence upon the adjoining areas of the left motor cortex. When the ape-man attained a sufficient degree of intelligence to wish to communicate with his fellows other than by mere instinctive emotional cries and grimaces, such as all social groups of animals employ, the more cunning right hand would naturally play an important part in such gestures and signs; and, although the muscles of both sides of the face would be called into action in such movements of the features as were intended to convey information to another (and not merely to express the personal feelings of the individual), such bilateral movements would certainly be controlled by the left side of the brain, because it was already more highly educated.

The Origin of Speech.

[This argument was elaborated to explain the origin of speech. The increasing ability to perform actions demanding skill and delicacy received a great impetus when the hands were liberated for the exclusive cultivation of such skill: this perfection of cerebral control over muscular actions made it possible for the ape-man to learn to imitate the sounds around him, for the act of learning is a training not only of the motor centres and the muscles concerned, but also of the attention, and the benefits that accrued from educating the hands added to the power of controlling other muscles, such as those concerned with articulate speech.

The usefulness of such power of imitating sounds could be fully realised in primitive man, not only because he had developed the parts of the brain which made the acquisition of such skill possible, but also because he had acquired, in virtue of the development of other cortical areas, the ability to realise the significance and learn the meaning of the sounds heard.]

I do not propose to discuss the tremendous impetus that the invention of speech must have given to human progress and intellectual development, in enabling the knowledge acquired by each individual to become the property of the community and be handed on to future generations, as well as by supplying in words the very symbols and the indispensable elements of the higher mental processes.

We are apt to forget the immensity of the heritage that has come down to us from former generations of man, until we begin dimly to realise that for the vast majority of mankind almost the sum-total of their mental activities consists of imitation or acquiring and using the common stock of beliefs. For this accumulation of knowledge and its transmission to our generation we are almost wholly indebted to the use of speech. In our forgetfulness of these facts

[12] Eug. Dubois, "Remarks upon the Brain-cast of Pithecanthropus," Proc. Fourth Internat. Cong. Zool., August, 1898, published Camb., 1899, p. 81.

[13] Boule and Anthony, "L'encéphale de l'homme fossile de la Chapelle-aux-Saints," *L'Anthropologie*, tome xxii., No. 2, 1911, p. 50.

we marvel at the apparent dulness of early man in being content to use the most roughly chipped flints for many thousands of years before he learned to polish them, and eventually to employ materials better suited for the manufacture of implements and weapons. But when we consider how slowly and laboriously primitive man acquired new ideas, and how such ideas—even those which seem childishly simple and obvious to us—were treasured as priceless possessions and handed on from tribe to tribe, it becomes increasingly difficult to believe in the possibility of the independent evolution of similar customs and inventions of any degree of complexity.

The hypothesis of the "fundamental similarity of the working of the human mind" is no more potent to explain the identity of customs in widely different parts of the world, the distribution of megalithic monuments, or the first appearance of metals in America, than it is to destroy our belief that one man, and one only, originally conceived the idea of the mechanical use to which steam could be applied, or that the electric battery was not independently evolved in each of the countries where it is now in use.

In these discursive remarks I have attempted to deal with old problems in the light of newly acquired evidence; to emphasise the undoubted fact that the evolution of the primates and the emergence of the distinctively human type of intelligence are to be explained primarily by a steady growth and specialisation of certain parts of the brain; that such a development could have occurred only in the mammalia, because they are the only plastic class of animals with a true organ of intelligence; that an arboreal mode of life started man's ancestors on the way to pre-eminence, for it gave them the agility, and the specialisation of the higher parts of the brain incidental to such a life gave them the seeing eye, and in course of time also the understanding ear; and that all the rest followed in the train of this high development of vision working on a brain which controlled ever-increasingly agile limbs.

If, in pursuing these objects, I may have seemed to wander far from the beaten paths of anthropology, as it is usually understood in this section, and perhaps encroached upon the domains of the Zoological Section, my aim has been to demonstrate that the solution of these problems of human origins, which have frequently engaged the attention of the Anthropological Section, is not to be sought merely in comparisons of man and the anthropoid apes. Man has emerged not by the sudden intrusion of some new element into the ape's physical structure or the fabric of his mind, but by the culmination of those processes which have been operating in the same way in a long line of ancestors ever since the beginning of the Tertiary period.

If I have made this general conception clear to you, however clumsily I have marshalled the evidence and with whatever crudities of psychological statement it may be marred, I shall feel that this address has served some useful purpose.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AMONG the honorary degrees to be conferred by the University of Leeds on October 3, in connection with the visit of the Iron and Steel Institute, are:—LL.D. on the president of the institute, Mr. Arthur Cooper, and degrees of D.Sc. on Sir Robert Hadfield, past-president, Mr. J. E. Stead, and M. Adolph Greiner, vice-presidents, and the president of the Society of German Ironmasters.

AMONG the public lectures to be delivered in connection with the opening of the new session at University College, London, we notice the following:—*Faculty of Arts.*—October 3, amulets, Prof. Flinders Petrie; October 4, the philosophy of Shadworth Hodgson, Prof. G. Dawes Hicks; October 5, general phonetics, D. Jones; October 9, introduction to comparative psychology, Carveth Read. *Faculty of Science.*—October 4, Joseph Dalton Hooker, Prof. F. W. Oliver. *Faculty of Engineering.*—October 9, the sources of energy available to man, Prof. J. A. Fleming.

IN connection with the Faculty of Engineering of the East London College, one of the constituent colleges of the University of London, a special course of lectures on the management of public electric supply undertakings has been arranged. The lectures will be given by Mr. A. Hugh Seabrook, and will commence on Monday evening, October 14. It is hoped by this means to arouse the interest of electrical engineers and others in the practical working of modern electrical undertakings. The principal of the college will be pleased to provide particulars of the fees for these lectures, and also of other special courses in connection with the engineering faculty of the college.

IT is unusual to find astronomy and meteorology among the subjects of courses of lectures arranged by a local education committee. We are glad to see that the Manchester Education Committee is an exception to the rule, and that such lectures are being given at the Municipal School of Technology. Mr. W. C. Jenkins is delivering a course of twenty-six lectures on descriptive astronomy in the Godlee Observatory, of which he is curator, dealing with the descriptive and popular aspect of astronomy; a course of twelve lectures on elementary meteorology, supplementary to those on descriptive astronomy, demonstrations to be given at the Meteorological Station, established in the garden adjacent to the Municipal Secondary School; and a course of twenty-six lectures on astronomical observations and the use of the Nautical Almanack for students familiar with the elements of astronomy.

THE Newcastle Section, the Society of Chemical Industry, and the Armstrong College are this winter arranging courses of evening lectures on special chapters in applied chemistry, which, it is anticipated, will prove specially interesting to those chemists and engineers already engaged in the industries. To inaugurate the scheme a special fund is being raised, which has already received liberal support from the principal manufacturers in the district. Two courses of five lectures each have been arranged for this winter, for which the committee has secured the services of well-known specialists. The first course is one on coal-gas manufacture and the carbonisation of coal, by Dr. Harold G. Colman, of London, and the second on metallography, by Dr. Desch, of Glasgow University. The first course will commence on October 16, and continue at fortnightly intervals; the second course is to commence on January 28, 1913.

THE East Ham Technical College begins its seventh session this month. Being situated in a district largely devoted to chemical industries, it endeavours to provide instruction suitable to the locality. The chemical department, which has been reconstructed during the vacation, comprises two lecture rooms, an inorganic laboratory, with bench accommodation for sixty-four students, an organic laboratory of similar dimensions, specially arranged for technological work, two smaller organic laboratories, and a research laboratory. A metallurgical subdepartment has been recently equipped. Practical and theoretical courses in pure chemistry extend over five years, and a college certificate is granted; there are also complete courses in gas engineering, gas supply and distribution, coal-tar distillation, chemical engineering, soap manufacture, painters' oils, colours and varnishes, oils, fats and waxes, metallurgy, and sugar manufacture, all of which are largely attended by students who are engaged either in the laboratories or on the plant in the respective industries.

MORE accommodation has for some time been urgently needed in the departments of bacteriology and public health of King's College (University of London). This has now been provided, with the sanction and approval of the University, by the removal of these departments with their staffs to 62 Chandos Street, Strand, W.C. (Charing Cross Medical School Buildings), where an excellent suite of laboratories is at present vacant owing to the transference of the Charing Cross Medical School's preliminary and intermediate medical studies to King's College. The laboratories at Chandos Street are being altered and refitted, and the accommodation there provided will comprise a large class laboratory, research laboratory, professors' laboratory, and lecturer's laboratory for each department, bacteriology and public health respectively; a photomicrographic laboratory, preparation and animal rooms; a large theatre, office, and library for the joint use of the two departments. There will be the regular courses of instruction in bacteriology, clinical pathology, and photomicrography, and for the diploma of public health. Research and investigation work for public bodies and others will also be carried on as before. The new laboratories will be opened on or about October 1. The laboratories vacated at King's College by this removal will be utilised for increasing the accommodation for the preliminary and intermediate medical studies.

THE volume of announcements of the Northampton Polytechnic Institute, London, E.C., for the session 1912–13 shows that the equipment of the institute has been steadily extended since last year, but there is no large item like a new generating station to report on this occasion. In the mechanical engineering department the equipment for experimental work in aëronautics has been considerably augmented and a new steam power plant has been laid down, which will enable students to experiment on the efficiency of steam plant from the coal and water to the brake of the engine with measuring appliances at every stage. In the evening classes in the electrical engineering department the heavy electrical engineering work now so well known is being continued. An important departure has been made in radio-telegraphy by the extension of the single course previously given to additional courses. The courses and classes in telegraphy and telephony have been remodelled to suit the changed conditions in the public services. In the mechanical engineering department the courses in aëronautical engineering have been further developed, especially on the experimental side. The new equipment referred to above will form a prominent feature of the laboratory instruction. The extensive work of this department in automobile and other branches of engineering is being continued. In technical optics and in technical chemistry the courses have been brought quite up-to-date, but there is no development that calls for special remark. The half-time trade courses in technical chemistry and in horology inaugurated last session are being further developed. In these classes the students, all of whom are engaged in commercial workshops, are in attendance from 9 a.m. to 1 p.m., and spend the afternoons in their employers' workshops. The experiment appears to meet the needs of the particular trades mentioned, and if it continues to be as successful as in the past year it will probably be extended to other trades.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 16. M. A. Grandidier in the chair.—H. **Deslandres**: The relations of the prominences with the filaments and *alignements* of the upper layers of the solar atmosphere. Further details on the character of the *alignements* and the filaments (long dark flocculi, absorption markings of Hale and Evershed). The *alignements* are subdivided into two classes, those with dark and with bright lines. The properties of the latter are consistent with the assumption of a circulation current of the upper atmosphere.—A. **Lacroix**: The mineralogical constitution of the volcanoes of the Island of Reunion. The essential characteristic of the mineralogy of Reunion is the production in the same volcano, and at the expense of the same magma, of well-characterised types of subalkaline and alkaline rocks. These have hitherto been regarded as necessarily of independent origin.—Fred **Vlès**: Remarks on the form of the sun and moon.—Paul **Gaubert**: The influence of the velocity of attack of calcite by acids on the form of the corrosion figures of this mineral. An account of experiments with calcite and dolomite when attacked with dilute solutions of hydrochloric, acetic, formic and nitric acids.—Walter T. **Swingle**: The slow artificial ripening of the Deglet-nour date. The Algerian date was introduced into the United States (Arizona and California) in 1900, but the fruit did not ripen properly on the tree. It has been proved that the dates may be ripened in twenty-four hours by incubation at a temperature of 43° to 49° C. It has now been found that in presence of moisture the fruit can be slowly ripened at the ordinary temperature.—M. **Foëx** and P. **Berthault**: A disease of maize in Cochin China. The disease, the effects of which are described in detail, is due to a fungus of the genus Dothiorella.—E. C. **Teodoresco**: The influence of temperature on nuclease. Nuclease from the plants studied only completely lost its diastatic properties after having been heated to about 90° C. The maximum diastatic action is at about 34° C.—Alphonse **Berget**: An arrangement of apparatus designed for the relative measurement of the acceleration of gravity.—De Montessus de **Ballore**: Earthquakes and sunspots.

CAPE TOWN.

Royal Society of South Africa, August 21.—Dr. J. K. E. Halm in the chair.—A. G. **Howard**: The blizzard of June 9–12, 1902. In continuation of the paper by Mr. Stewart, read in November, 1904, before the South African Association for the Advancement of Science, the writer of the present paper brings to notice a series of synoptic charts of the weather conditions from June 8 to 13, 1902, inclusive.—J. **Hewitt** and J. H. **Power**: A list of South African Lacertilia, Ophidia, and Batrachia in the McGregor Museum, Kimberley, with field notes on various species. The paper is offered primarily as a contribution to our knowledge of the fauna of the Kimberley district. The present-day fauna of that neighbourhood is shown to be composite, a new element having been introduced along with timber from Bechuanaland. The faunistic lists are accompanied with field notes, and in the case of some of the Batrachia the authors have been able to give a short account of the larval metamorphosis.—Dr. **Dreyer**: The salivary and mouth glands of the Nudibranchiata. W. T. **Saxton**: The leaf-spots of *Richardia albo-maculata*, Hook. The author describes the structure and development of the white streaks characteristic of the leaves of two species of Richardia, and discusses their origin.—Dr. R. **Marloth**: Some new or little known South African succulents.

BOOKS RECEIVED.

Parallel Paths: a Study in Biology, Ethics, and Art. By T. W. Rolleston. Pp. xv+299. (London: Duckworth and Co.) 2s. 6d. net.

Compendio Elemental de Zoologia. By A. Gallardo. Pp. 360. (Buenos Aires: Angel Estrada y Cia.)

Handbook of Fungus Diseases of the Potato in Australia and their Treatment. By D. McAlpine. Pp. iii+215+1 map. (Melbourne: J. Kemp.)

Gravitation. By F. Harris. Pp. xi+107. (London: Longmans and Co.) 2s. 6d. net.

Proceedings of the Aristotelian Society. New Series. Vol. xii. Pp. 345. (London: Williams and Norgate.) 10s. 6d. net.

Butterflies and Moths at Home and Abroad. By H. Rowland-Brown. Pp. 271+21 plates. (London: T. F. Unwin.) 7s. 6d. net.

China. Ergebnisse eigener Reisen und darauf gegründeter Studien. By F. v. Richthofen. Dritter Band, Das südliche China. Edited by E. Tiessen. Pp. xxxi+817+5 plates. Fünfter Band, enthaltend die abschliessende palæontologische Bearbeitung der Sammlungen F. von Richthofens, die Untersuchung weiterer Fossiler Reste aus den von ihm bereisten Provinzen sowie den Entwurf einer erdgeschichtlichen Uebersicht China's. By Dr. F. Frech. Pp. xii+289+31 plates.

Atlas von China. Orographische und geologische Karten von F. von Richthofen, zu des Verfassers Werk China: Ergebnisse eigener Reisen und darauf gegründeter Studien. Zweite Abtheilung. Das südliche China (zum dritten Textband gehörig). By Dr. M. Groll. Pp. 12+plates 27–54. (Berlin: D. Reimer.) Band III. and V., 32 marks; Atlas, 52 marks.

Modern Research in Organic Chemistry. By F. G. Pope. Pp. xii+324. (London: Methuen and Co., Ltd.) 7s. 6d.

A Second Year Course of Organic Chemistry for Technical Institutes. By F. B. Thole. Pp. vii+186. (London: Methuen and Co., Ltd.) 2s. 6d.

Chrysanthemums. By T. Stevenson, with chapters by C. H. Payne and C. E. Shea. Pp. xiii+112+8 coloured plates. (London and Edinburgh: T. C. and E. C. Jack.) 1s. 6d. net.

Heredity and Eugenics. By W. E. Castle, J. M. Coulter, and others. Pp. vii+315. (Chicago: The University of Chicago Press; Cambridge University Press.) 10s. net.

Papers and Proceedings, Sixth Annual Meeting, American Sociological Society, held at Washington, D.C. December 27–30, 1911. Vol. vi. Pp. v+101. (Chicago, Ill.: The University of Chicago Press; Cambridge University Press.) 6s. net.

Theories of Solutions. By S. Arrhenius. Pp. xx+247. (New Haven: Yale University Press; London: H. Frowde.) 12s. 6d. net.

The Elementary Geography. By F. D. Herbertson. Vol. v., pp. vi+152+4 maps. Vol. vi., pp. vi+186+4 maps. (London: H. Frowde.) 1s. 6d. and 1s. 9d.

Transactions of the American Institute of Chemical Engineers. Vol. iv., 1911. Pp. iv+514. (New York: D. van Nostrand Co.; London: E. and F. N. Spon, Ltd.) 30s. net.

Practical Geometry and Graphics. By E. L. Bates and F. Charlesworth. Pp. viii+621. (London: B. T. Batsford.) 4s. net.

Practical Mathematics. By E. L. Bates and F. Charlesworth. Pp. viii+513. (London: B. T. Batsford.) 3s. net.

Wild Life in the West Highlands. By C. H. Alston. Pp. x+271. (Glasgow: J. MacLehose and Sons.) 6s. net.

Scientific Method: its Philosophy and its Practice. By F. W. Westaway. Pp. xix+439. (London: Blackie and Son, Ltd.) 6s.

South African Geology. By Prof. E. H. L. Schwarz. Pp. vi+200. (London: Blackie and Son, Ltd.) 3s. 6d. net.

Anales de Psicologia. Volumen ii. By A. Florentino and others. Pp. 360. (Buenos Aires: *La Semana Médica*. Imp. de Obras de e. Spinelli.)

The Concrete Institute. Transactions and Notes. Vol. iv. Part ii. (London: The Concrete Institute.)

Photography of To-day. By H. Chapman Jones. Pp. 342. (London: Seeley, Service and Co., Ltd.) 5s. net.

The Humble-bee: its Life-history and How to Domesticate it. With Descriptions of all the British Species of Bombus and Psithynus. By F. W. L. Sladen. Pp. xiii+283. (London: Macmillan and Co., Ltd.) 10s. net.

La Tecnica delle Correnti Alternate. By Prof. G. Sartori. Volume Primo. Seconda edizione ampliata. Pp. xiv+558. (Milano: U. Hoepli.)

CONTENTS.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

No. 2240, VOL. 90] THURSDAY, OCTOBER 3, 1912 [PRICE SIXPENCE

Registered as a Newspaper at the General Post Office.]

THURSDAY, OCTOBER 3, 1912.

THE SPECIFIC TREATMENT OF TUBERCULOSIS.

The Treatment of Tuberculosis by means of the Immune Substances (I.K.) Therapy. An introduction to Carl Spengler's work on Immunity and Tuberculosis. By Walter H. Fearis. With a Foreword by Dr. Carl Spengler. Pp. xx + 206. (London: John Murray, 1912.) Price 6*s.* net.

THOSE who turn to this book for an account of Spengler's work and records will, we are afraid, be sorely disappointed. The opinions of an enthusiastic admirer of Dr. Carl Spengler, his school, and its work are here in abundance, but any detailed description of much that is peculiar to Spengler's method is wanting.

We are told, however, that in man tuberculous infection is a symbiotic infection, and that with rare exceptions two antagonistic types of tubercle bacilli are found:—(1) *Typus humanus brevis*, Koch; (2) *humano-longus*, Spengler, this latter differing from the *Typus bovinus* only in that it branches more and forms pigment, that it is less acid-fast, is more sensitive to the action of distilled water, is more highly pathogenic to cattle, rabbits, guinea-pigs, and adult human beings, and that there are differences between the two as regards certain optical properties. It is interesting to note that Spengler believes that although the two types, *bovinus* and *humano-longus*, are morphologically identical, their pathogenic action is markedly different; still, he rejects experiments on animals as being of little or no value in helping to distinguish between the different types.

It is insisted that the toxins of the true bovine bacillus are antagonistic to those formed by Koch's *Bacillus brevis* and the converse, and also that whilst the toxins of the true bovine bacillus act as vaccins towards man, those of Koch's *Bacillus brevis*, with rare exceptions, act as toxins towards man. Whatever may ultimately be accepted as to this and other points, the arguments as here put forward are scarcely convincing. Much of the latter part of the book is devoted to an attempt to prove that Dr. Carl Spengler was chiefly responsible for the development of Koch's tuberculin treatment, and that, following this up, he has devised a method for the production of an immunity in which are combined both active and passive elements.

This method depends on the production of certain immune substances or antibodies in the sheep or rabbit, whence, apparently, they can be transferred to the human subject, these immune bodies sometimes being used along with tuberculin, but, in certain cases, alone. Bacteriological methods of examining sputum, &c., of determining the amount of antitoxic substance in the "I.K.," special methods of inoculation, dry, subcutaneous, intramuscular, and the like, are described, and a series of directions for treatment are given, the most important of which (noted after long descriptions of systematic treatment) appears to be—watch the condition of the patient, and then inject just as may be thought fit. A rapid precipitation method used in determining the approximate immunity value of a sample of blood is mentioned, and figures bearing on these values are given, but nowhere is anything said about the method itself.

From this, and from other features of the book, one cannot help feeling that the work before us is the outcome of observations and discussion amongst a set of enthusiastic workers at a subject concerning which the author, at least, is content to accept everything that is put before him, whether he understands it fully or not. This somewhat serious statement is made after due consideration, though it may be that the author is so full of the methods here suggested that he is unaware of the ignorance of many of us "outsiders" of what, in the circle in which he moves, is common knowledge. Nowhere is this more marked than in connection with the reports of different physicians who are recorded as giving evidence for and against "I.K." treatment. There may be a very great field for this treatment, and this book may stimulate those interested to a further study of Carl Spengler's methods, but in it are collected such a mixture of elementary details and imperfect accounts of very difficult and complicated questions that it will certainly fail in its main object, *i.e.*, to be "of real practical value to the physicians who may desire to administer this treatment."

In an introductory note Dr. Carl Spengler writes: "Obgleich mir das vorliegende Buch nur in seiner Disposition bekannt ist. . . ." This is well for Dr. Spengler if he be a fairly modest man, but whether it is equally good for the book is another matter, and we suggest that in the larger work that is promised by the author an attempt should be made to cut out a number of the "Carl" Spenglers, "I.K.'s," and the almost endless repetitions by which the pages of this book will appear, to most readers, to be disfigured. Indeed, many will be so irritated by this constant repetition and reiteration that there will be great risk of any real merit in the work being overlooked.

Finally, in giving explanations, statistics, and comparative results, the author appears to be under the impression that if he makes a statement sufficiently frequently it must ultimately be accepted by any reasonable individual. May we make the suggestion that when the larger work appears it should contain more accurate accounts of the really fundamental differences between Spengler's work and that of his contemporaries, that full descriptions of all special methods be given, and that, in order to make room for many things that are here taken for granted, much irrelevant matter and repetition should be omitted?

SCIENCE OF TANNING.

The Puering, Bating, and Drenching of Skins. By J. T. Wood. Pp. xv+300. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1912.) Price 12*s*. 6*d*. net.

THE author in his preface claims that this volume is merely a collection of notes he has made during the past twenty years on the practical and scientific aspect of the puering, bating, and drenching of skins. "Puering" and "bating" are two processes commonly used in the manufacture of light and fancy leather from various skins. They consist of steeping the skins prior to tanning in a fermenting solution of excrement—in the case of "puering," dog excrement is used; in "bating," hen or pigeon manure. Subsequent to either of these processes the skins are "drenched," in which process they are placed in a fermenting solution of bran, which, by reason of its acid nature, swells the skins prior to tanning. The original of the words puering and bating is French *puer*, to stink; *bête*, animal. The aim of scientific technologists is to substitute these two disgusting processes by cleaner materials which can be scientifically controlled. Puering and bating of skins reduce them in thickness, take out the lime and grease, and make them soft and velvety. Mr. Wood has put together his notes upon these subjects in such a way as to make this volume indispensable both to leather trades chemists and to those who wish specially to study the subject. It is, in short, a text-book bringing together in handy form all that has been done and all that is known of this, one of the most complicated processes in connection with leather manufacture.

In the first chapter the author gives an outline of the practical processes of puering and bating. This chapter deals more with the practical side, although scientific data are given in the form of analyses and analytical results connected with practical trials. The author describes also the use of Sand's electrometric apparatus for the controlling of puer and bate liquors.

In subsequent chapters the author deals with the physics and chemistry of bating. These chapters are probably beyond the ken of the average leather manufacturer, as the author deals with the measurement of the hydrogen-ion concentration, the conductivity of puer liquors, and also describes a new apparatus for measuring the degree of falling, illustrating the work of the instrument by curves.

Chapter iv. deals with the bacteriology of the bate, and here the author excels and gives a fund of information which will be most valuable to all branches of the leather industry. The author gives microphotographs of many of the active bacteria of the puer and bate, some of which have been isolated and named by himself.

The remaining chapters contain a number of Mr. Wood's original papers which have been contributed to various learned societies from time to time. A further chapter deals with artificial bates which from time to time have been suggested, some of which are being used with satisfactory results. Lastly, Mr. Wood has collected in convenient form a *résumé* of all the patents and the bibliography of the subject.

A special portion of the book deals with drenching, one of the subsequent processes to puering or bating, and one which must be treated quite apart. Various analyses and bacteriological investigations are fully described.

The book is one which all interested in the scientific side of the leather trade must possess. To the practical leather manufacturer the book may be a disappointment, as the author does not deal with the old practical difficulties.

Mr. Wood describes his book in the concluding chapter as follows:—

"Limited in extent, imperfect in execution, and in parts only suggestive in character, this little book may perhaps serve as a foundation on which students of the science of tanning may raise the superstructure of their own experience and eventually perfect the processes touched upon, so that the use of such filthy materials may be entirely avoided."

This is another example of Mr. Wood's modesty. The book goes further than he claims. It is indeed refreshing to find someone brave enough to publish the results of his years of study of this, one of the least understood and most complicated processes connected with the manufacture of leather.

Needless to add, the printing, illustrations, and the general get-up of the book leave nothing to be desired.

J. G. P.

THREE BOOKS ON AGRICULTURE.

(1) *Fertilisers and Crops; or, The Science and Practice of Plant-Feeding.* By Dr. L. L. Van Slyke. Pp. xiv+734. (New York: Orange Junn Company; London: Kegan Paul and Co., Ltd., 1912.) Price 2.50 dollars.

(2) *Farm Dairying.* By Laura Rose. Pp. 303. (London: T. Werner Laurie, n.d.) Price 6*s.* net.

(3) *Fungoid Diseases of Agricultural Plants.* By Prof. Jakob Eriksson. Translated from the Swedish by Anna Molander. Pp. xv+208. (London: Baillière, Tindall and Cox, 1912.) Price 7*s.* 6*d.* net.

(1) THE system of soil depletion as practised in the United States of America and in our colonies is beginning to receive serious consideration from the agricultural economist. The continuous growth of grain crops and the failure to make any adequate returns of plant food to the soil soon lead not only to a lack of food reserve, but also to the loss of those organic compounds which are of such importance in the production of crops in dry regions. This in itself is deplorable enough, but even where manure is to be had much of its fertilising value is wasted. Dr. van Slyke puts forward the interesting computation that the annual loss caused by the careless treatment of the manure produced by the different farm animals in the States is equivalent in value to an annual wheat crop in that country, or to 700,000,000 dollars.

With a view to minimise this and similar losses caused by haphazard use of artificial manures, this book has been written, and is designed to meet the requirements of farmers and classes in agricultural colleges and high schools. The treatment is such as to lay a foundation in the general principles relating to soil fertility and plant nutrition, and to stimulate a desire on the part of the reader to know more about the subjects discussed. In this way it would serve as an introduction to special treatises on agricultural chemistry, soil physics, plant physiology, soil bacteriology, &c.

The four parts of the book each contain a number of chapters under the heading of factors of soil fertility, sources and composition of materials used as fertilisers, factors in the selection of fertilising materials, and the practical use of fertilisers in the growing of individual crops. The last part is distinctly valuable from the grower's point of view.

The book is copiously illustrated and is to be warmly recommended for anyone interested in the production of farm and garden crops.

(2) The second publication would appear to be intended for a large and general class of readers, viz., the members of farm households. The subject matter is divided into fifty-two chapters, and deals in a brief manner with many questions, not perhaps vital, but incidental to success and comfort in farming. The book contains advice on the general arrangements of farm buildings, the care and feeding of the cow, butter- and cheese-making, milk-testing, and the treatment of the common diseases of cattle. In perusing this book one cannot help feeling that much of the space occupied by minor issues might well have been devoted, with much advantage, to a more detailed treatment of farm operations; for instance, the mixing of limewash is given as much prominence as the discussion of feeding rations. The book is well illustrated and might possibly conduce to a better understanding of farm and dairy work.

(3) Prof. Eriksson's work will be welcomed by agriculturists and horticulturists as a valuable contribution to our literature on the subject. It is intended, primarily, as a practical guide for planters and to enable them to recognise, prevent and battle with diseases often occurring in practice. Bacterial and fungal diseases of common farm and garden crops are admirably described and preventive and remedial measures are treated in detail. A special chapter deals with unexplored diseases, whilst a useful appendix of diseases, arranged according to the host plant, is included.

TOPOGRAPHY AND GEOGRAPHY.

(1) *The Land of Goshen and the Exodus.* By Sir Hanbury Brown, K.C.M.G. Second edition. Pp. 92+2 maps. (London: Edward Stanford, 1912.) Price 3*s.* net.

(2) *Rambles in the Pyrenees and the Adjacent Districts, Gascony, Pays de Foix and Roussillon.* By F. Hamilton Jackson. Pp. xii+419. (London: John Murray, 1912.) Price 21*s.* net.

(3) *The Oxford Country.* Its Attractions and Associations described by several authors. Collected and arranged by R. T. Günther. Pp. xvi+319. (London: John Murray, 1912.) Price 7*s.* 6*d.* net.

(4) *Man and his Conquest of Nature.* By Dr. M. I. Newbigin. Pp. viii+183. (London: A. and C. Black, 1912.) Price 2*s.* (Black's School Geography Series.)

(1) SIR HANBURY BROWN takes the opportunity of this second edition of his study of the journey of the Israelites from Egypt to deal with some of the criticisms met with by the first edition. The subject is one which has received attention from a number of writers in

various aspects, such as the direction of the exact route followed, and the explanation of the various events which preceded and accompanied the journey, and bear on their face in the original narrative an appearance of the supernatural; for some of these natural explanations are afforded, as in the case of the passage over the Red Sea, without imposing any strain upon the received text. The short volume carries the journey as far as Elim, and the discussion is illustrated with two maps, which are noteworthy as indicating the author's view of the further northward extension of the Arabian Gulf at the time of the Exodus.

(2) Mr. Hamilton Jackson has produced a beautiful volume on a fascinating region. He deals with the Pyrenean lands from a general descriptive point of view, but his main interest, which is that of architecture, obtains the greatest share of attention, not only in his text, but more especially in the fine illustrations which come both from his own pen and from photographs by Mr. J. C. Ashton, which are excellent, and excellently reproduced. The French Pyrenean country is one of which travellers from this country know less than it deserves. Some of its monuments of antiquity, such as the city of Carcasonne and the church of St. Bertrand de Comminges, are unsurpassed in interest elsewhere in Europe, and of these and many others the author supplies full descriptions.

(3) It was a happy idea to bring together a collection, by various authors, of articles which have appeared from time to time in *The Oxford Magazine* and elsewhere, on the country neighbouring to Oxford, its geology, natural history, archæology, and the like. The territory, within a radius (let us say) of twenty miles of Oxford, is one which includes a remarkable variety of types of English rural scenery, such as the fresh charm of the Thames above Oxford and its more mature beauties below, the bolder scenery of the hills south of White Horse Vale, or the curious fen-like expanse of Otmoor. This country succeeds in exerting its charm over a good proportion of the sons of Oxford, among whom many well-known names appear as authors in this volume. Among writers who discuss scientific studies of one sort or another may be mentioned Prof. Poulton, Prof. Warde Fowler, Dr. Aplin, and Mr. Claridge Druce; while no less notable are the names of those who deal with other aspects of the country. The volume has been excellently arranged by Mr. R. T. Günther, who contributes a chapter on the Rollright Stones.

(4) Dr. Newbigin has already in her "Modern Geography" shown herself to be a student of that subject along the lines indicated chiefly by the name of "human geography," an important department which is receiving continually growing attention as an educational topic. In the present volume she deals mainly with the economic aspect in this department, showing how certain regions are suited, whether well or ill, by their climatic and physical conditions, for the cultivation of plants of economic value; how the distribution of minerals affects human settlement, and also how the products of the sea have done so. She deals skilfully with the inter-relation of these considerations in their effect upon the density of settlement and upon conditions of life. The book is suited for teachers and more advanced students; it has none of the less attractive characteristics of the school-book.

OUR BOOKSHELF.

Ueber die Einwirkung von Wasser und Natronlauge auf Baumwollecellulose. By Dr. Ing. Michael Robinoff. Pp. ii+94. (Berlin: Gebrüder Borntraeger, 1912.) Price 3.60 marks.

THIS is an account of investigations of cotton cellulose in regard chiefly to constitutional modifications determined by treatment with water, and with alkaline solutions (NaOH) under widely varied conditions of action. The author's work further confirms the diagnostic value of the reactions of cellulose with cupric oxide (alkaline solution), viz., (*a*) the reaction of combination, or fixation of CuO; (*b*) reduction.

These have been brought into prominence by Prof. C. G. Schwalbe, and are adopted, together with a special terminology, by a number of workers in Germany. The quantitative results are expressed as coefficients in terms of Cu per cent. cellulose, but under descriptive terms, such as "Cellulosezahl," "Korrigierte Cellulosezahl," which are not happily selected.

The results recorded are of considerable empirical value, and the author keeps with evident intention to a strictly empirical interpretation, particularly pointing out the bearings of the constitutional modifications resulting from the action of water at temperatures 100° to 150° C., dilute solutions of sodium hydrate (1-5 per cent. NaOH) at similar temperatures, more concentrated solutions in the cold (mercerisation reactions), upon the various treatments of cellulose textiles incidental to "bleaching" and lustre-finishing.

By means of the careful systematic application of the reactions in question, he is enabled to establish constitutional modifications of cotton cellulose resulting from treatments of such feeble chemical intensity as (1) contact with highly dilute acids in the cold, and (2) the papermakers' beating processes, in the convincing form of self-consistent numbers. He is thus able to confirm the general statements in the leading text-books, that cellulose responds to all and any chemical treatment, however feeble, by constitutional changes, and, as a particular case, that the beating preparation of the fibrous celluloses is in effect a hydration process.

The Main Drainage of Towns. By F. Noel Taylor. Pp. xi+313; illustrated. London: Charles Griffin and Co., Ltd., 1912.) Price 12*s.* 6*d.* net.

DESPITE the fact that this book is entitled "Main Drainage of Towns," the author has attempted the almost impossible task of dealing, in the course of 295 pages, not only with matters strictly pertaining to main drainage work, but also with questions of house drainage, the theoretical side of sewage disposal, sewage disposal works, &c.

It is therefore scarcely surprising to find that the author has not been successful in his treatment of the whole of the above subjects, particularly as throughout the work there is unmistakable evidence of the lack of that careful revision of the text so essential to the production of a scientific work of value.

In justice to the author, it should be stated that he has collected a great deal of useful information in regard to main drainage work, together with a large number of plans, tables, &c., which must have entailed considerable labour. On the other hand, the value of the book is very seriously impaired by the careless way in which it is written, the errors in composition being in many cases so serious as to render the meaning of the text obscure.

Careful perusal of the chapters relating to the theory of sewage disposal, sewage disposal works, &c., clearly indicates that the author would have been well advised to have left this part of the subject alone, especially in view of the various excellent text-books already available on the subject of sewage purification.

The book contains sufficient material for the production of a useful work on the subject of main drainage providing the matter is carefully edited, but as published it certainly cannot be recommended. E. A.

LETTERS TO THE EDITOR.

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

A Tribe of White Eskimos.

CONSIDERABLE interest has been aroused by the announcement made by M. Vilhjalmar Stefansson (see NATURE of August 22, p. 644), communicated to the Press through Reuter on September 10, that he had discovered a tribe—or, to be more accurate, thirteen tribes—of white Eskimos living in the neighbourhood of Coronation Gulf and Victoria Island. It is stated that ten of these tribes had never heard of white people—other than themselves. Consequently, it cannot be assumed that this fair complexion is derived from the intercourse, so frequent in recent times, between Eskimos and the men of whaling ships. The telegraphed account states that "M. Stefansson believes the white Eskimos are descendants of the colony which set out from Norway to Greenland some time after the discovery of that island. Ethnologically, the white Eskimos bear not a single trace of the Mongolian type, differing in the shape of the skull and general features, colour of eyes, and texture of hair, which in many cases is red. They spoke Eskimo, though the explorer thought he detected some Norse words. They probably numbered two thousand. Many of them had perfectly blue eyes and blonde eyebrows."

It is, of course, quite possible that a newspaper correspondent may have given a very free rendering of the statements made to him by M. Stefansson. But, in any case, it is important to bear in mind that a description of a race of fair-complexioned Eskimos, living on the shores of Davis Straits, was printed in Europe in 1658. This account occurs in De Poincy's "Histoire Naturelle & Morale des Iles Antilles de l'Amérique," which was published at Rotterdam in that year, and contains a chapter (xviii.) incorporating the narrative of Nicolas Tunes, captain of a Flushing vessel, just returned from Davis Straits at the time when De Poincy was occupied with a description of the narwhal—a subject which led him into a long digression on the hunters of the northern narwhal. De Poincy indicates the locality in question in the following terms, here translated from his somewhat archaic French:—"The captain, from whom we have received this narrative, having set out from Zealand at the end of the spring of 1656, with the intention of discovering some new source of trade in those northern lands, arrived at the end of June in Davis Straits, whence, having entered a river which begins at 64° 10′ N. lat., he sailed to the seventy-second degree, where the land about to be described is situated."

A very full description is given of the natives, but only the following sentences need be quoted here:—"As regards the inhabitants, our travellers report having seen two kinds, who live together on the most friendly terms. Of these, one kind is described as very tall, well-built, of rather fair complexion, and very swift of foot. The others are very much smaller, of an olive complexion, and tolerably well-proportioned, except that their legs are short and thick. The former kind delight in hunting, for which they are suited by their agility and natural disposition, whereas the latter occupy themselves in fishing. All of them have very white, compact teeth, black hair, animated eyes, and the features of the face so well made that they present no notable deformity. Moreover, they are all so vigorous and of such a strong constitution that several of them who have passed their hundredth year are still lively and robust."

In the small, olive-complexioned, short-legged people here described, there is no difficulty in recognising true Eskimos. Those of the tall, comparatively fair type may easily have been the descendants of the Norse colonists, intermingled, it may be, with Eskimos. It is believed by many—for example, by Dr. Nansen ("In Northern Mists," London, 1911, vol. ii., p. 103)—that the early Norsemen in Greenland were not exterminated by the Eskimos, but were gradually absorbed by them through successive intermarriages. Admitting this, it would seem that the fusion of the two races was still only partial in 1656. Tunes and his comrades speak of black hair as common to both types, but that need not mean much. If black hair was not common among tenth-century Norsemen, there would have been no distinction in Harald's designation of *haar-fager.*

However, the point is that an expedition of the year 1656 reported a tall, light-complexioned caste of natives living on the shores of Davis Straits at the same time as others of genuine Eskimo type. It is quite possible that the former, still retaining their individuality, may have migrated westward to Victoria Land. DAVID MACRITCHIE.

4 Archibald Place, Edinburgh, September 23.

Antiquity of Neolithic Man.

THE letter of Mr. J. Sinel, in NATURE of September 19, on the submerged forest bed in Jersey, deals with several questions of great interest in relation to the submerged forest on the south-western coast of Wales. I hope to publish shortly an account of this forest-bed (so far as it is seen in Pembrokeshire) and the deposits associated with it, but in the meantime I may state that I have found worked flints—flakes and cores—in two localities on the Pembrokeshire coast in positions which correspond with that of the stratum of blue clay below the forest-bed at St. Heliers. These flints were clearly worked by men who inhabited the woodland, now submerged, before the trees fell into decay and formed the peaty mass of trunks, branches, leaves, &c., overlying the true root-bed of the "submerged forest." One locality near Amroth, in Carmarthen Bay, yielded cores and flakes in abundance; the circumstances indicate the existence of a chipping-floor or implement-factory on this part of the submerged land-surface, which now, during spring tides, is covered by not less than 20 ft. of water. In the patch of submerged forest recently exposed at Freshwater West, in southern Pembrokeshire (see NATURE, March 28, 1912), a few small flint implements were also found.

Both at Amroth and Freshwater West the flints occurred below the peaty layer in a thin blue slime or clayey silt, which rests in turn upon clayey rubble largely composed of material derived from older superficial deposits. There is evidence that the forest trees in Pembrokeshire are rooted either in unquestionable glacial Boulder Clay or in a clayey drift allied to the glacial deposits. There appears, therefore, an interesting agreement in the character of the substratum of the submerged forest in Jersey and on the Pembrokeshire coast, and the agreement further extends to the composition of the peat. All the plants (with others) mentioned by Mr. Sinel occur in the peat near Amroth and the remains of beetles are fairly common.

A point of difference, which may be more apparent than real, between the two localities, is the occurrence, according to Mr. Sinel, of blue "marine" clay below the peat at St. Heliers. In Pembrokeshire the blue slime, whence the flints were obtained, has yielded no evidence of marine origin; it appears rather to resemble an old marsh silt which developed into swampy soil, but it is quite possibly only the estuarine fringe of a marine clay which is now wholly submerged. The deposits, it may be, would be similar if compared at corresponding levels.

The geological horizon of the worked flints of the Pembrokeshire submerged land-surface appears identical with that of the Neolithic implements from St. Heliers. One of the most important questions that arises is whether these implements are so distinctively Neolithic in character as to exclude the possibility that they may belong to an earlier period. Two implements from the Pembrokeshire submerged forest were submitted to Mr. Reginald Smith, of the British Museum, but they were not found sufficiently characteristic in form to be dated according to modern detailed classifications of implements.

The term "Neolithic" is frequently applied to any surface finds of implements which are unabraded and not obviously of the familiar heavy Palæolithic forms. But while on the one hand many so-called "Neolithic" implements belong to the later prehistoric ages of Bronze and Iron, on the other hand some surface sites yield implements closely resembling Late Palæolithic types. This is so, for instance, in South Pembrokeshire, where recently I have obtained from several chipping-floors on the high ground bordering the coast a number of small implements, amongst which Mr. Reginald Smith has recognised several scrapers, probably of Late Palæolithic (Aurignacian) types. But some of these early forms occur on sites which have yielded also typical Neolithic tools (with ground edges) and pottery, and, moreover, it is not yet possible to show that they are older than the submerged forest.

I join with Mr. Sinel in expressing the hope that other records of implements from the submerged forest may be obtained, but further I should like to suggest that it is of great importance that all finds should be compared with the series of implements in our national collections in order that their age may be definitely ascertained. A. L. LEACH.

Giltar, Shooter's Hill, London.

Human Jaw of Palæolithic Age from Kent's Cavern.

PROF. A. KEITH, in discussing the paper read at Dundee by Prof. Boyd Dawkins for Dr. Duckworth on the fragment of a jaw of Palæolithic age from Kent's Cavern, is reported by *The Times* to have said that "the whole thing was ridiculous and was not even scientific, for the specimen had not been shown in the position in which it had been found."

The specimen in question is in the museum of the Torquay Natural History Society. Its position has been defined in the late Mr. W. Pengelly's reports to the British Association, and more particularly in his Cavern Note-book and Diary, which are at present, with all his other records of Kent's Cavern, in the possession of his elder daughter, Mrs. Louis Maxwell.

By the kindness of Mrs. Maxwell, I have had the opportunity of examining the diary, and have also had a look at the specimen now in its place in the museum. The actual record of the fragment is as follows:—"Thursday, January 3 [1867]. To the Cavern. The objects found to-day were as below:—

"No. 1930. In granular stalagmite. 7th Parallel, including part of a Human Jaw, a Flint Flake, a well-rolled Flint pebble from which a chip had been broken."

In the British Association's Third Cavern Report, 1867, the further fact is stated, viz. that the object was found "'about 30 feet from the Northern Entrance to the Cavern and deeply imbedded in Granular Stalagmite 20 inches thick."

The position of the jaw in the cavern is thus ascertainable to a few feet, and its depth in the stalagmite to a few inches. But it tells its own tale. It is practically a specimen of the characteristic granular stalagmite, which seems to have been of Palæolithic age throughout. Pengelly mentions (Fifth Report) how cave bear, hyæna, and rhinoceros were met with not only in the granular stalagmitic floor, but quite at its upper surface (Trans. Devon Assoc., v., xvi., p. 250). Indeed, Pengelly records the occurrence of a tooth of rhinoceros found in another part of the cavern (No. 4090, found May 27, 1869), "which was not only in quite the upper part of the stalagmite, but instead of being completely covered, projected above its surface" (Trans Devon Assoc., vol. xvi., p. 207).

Having known Kent's Cavern long before the British Association exploration, and having been instructed therein by Mr. Pengelly for cave research elsewhere, I trust you will permit me to bear this testimony to the accuracy and detail of Pengelly's Kent's Cavern records.

I may mention that in 1884 Pengelly collected the whole of the sixteen Kent's Cavern reports in a single paper to the Devonshire Association. Not only is this paper much more convenient for reference than the reports scattered over sixteen years of the British Association, but occasional notes review the early evidence. For instance, with reference to the jaw under discussion Pengelly adds the remark, "Nothing of the kind was subsequently met with in or under the Granular Stalagmite" (*loc. cit.*, p. 221).

A. R. Hunt.

Torquay, September 16.

Mr. Hunt is under a misapprehension regarding my criticism of Prof. Boyd Dawkins's communication at the Anthropological Section of the British Association at Dundee. In making the important announcement that the remains of Neanderthal man had been discovered in England, Prof. Dawkins exhibited merely a rough sketch of a fragment of a human jaw —not the actual specimen itself. So far as the sketch went it showed none of the usual Neanderthal characters. Further, he was unable to say from which stratum of the floor of Kent's Cavern the original specimen had been derived. My criticism of "ridiculous" and "unscientific" applies merely to the fact that the meeting was asked to accept the discovery of Neanderthal man in England on a specimen which was absent and of uncertain origin. From Mr. Hunt's communication it is clear that the exact origin of the specimen could have been ascertained. I firmly believe that the remains of Neanderthal man will be discovered in England—it may be that Dr. Duckworth is right regarding the specimen from Kent's Cavern—but the discovery cannot be accepted unless the evidence is produced.

A. Keith.

EXPERIMENTAL RESEARCHES ON VARIATIONS IN THE COLOURING OF LEPIDOPTERA.[1]

This is a very comprehensive treatise by Dr. Pictet, a former treatise by whom on a cognate subject was reviewed in Nature in 1905 (vol. lxxii., p. 632). It begins with a *résumé* of previous researches by various authors, classified under several heads, and proceeds to describe the author's own researches and the conclusions he draws from them. Many of the details are highly interesting, and his observations upon them are of much weight.

Lepidoptera, Dr. Pictet tells us, with few exceptions, vary in only two directions, melanism and albinism; the law laid down by Oberthur may be thus summed up: Any part of the wing of a butterfly can become separately darker or lighter than it is normally; in the former case, whatever its colour (except green) it can darken sufficiently to become brown, and even of so deep a brown as to have the appearance of blackness, leading in all the parts so darkened to melanism; in the latter case these same parts can become lighter, sufficiently to become tawny (*fauve*), yellow, and even of a yellow so pale as to appear white, leading, in like manner, to albinism.

The dark markings of the wing can spread or be displaced, or merge in neighbouring parts, or mask them more or less completely, or they can contract, become partly effaced, or even disappear, giving place to the light markings of the ground colour (*fond*). In other cases certain markings may become darker, and others lighter, or the general colour may become darker or lighter without altering the pattern. Opposite exciting causes, *e.g.* heat and cold, may produce the same result, this being caused, not by the special quality of the abnormal factor, but by the fact of the passing of the individual from a normal environment to that which does not suit it.

Among the exciting causes M. Pictet includes, but apparently with some doubt, electricity and mechanical vibration (*trépidation*)—the last, I believe, has been abandoned.

As regards the mechanism of variation, this has its principal seat in the scales, all of which, whether red, yellow, white, brown, or black, as well as the blue and violet ones, are striated on the surface so as to be capable of displaying the optical colours, and most of which are more or less filled with pigment in a granular form. The optical effect is related to the quantity of pigment in the scale, the intensity of the iridescence growing in inverse proportion to the pigment. In many cases the basal part of a scale is less filled with pigment than the distal part. Where the colours of the wing are light, the scales generally contain less pigment than where the colours are darker. There are, however, white pigment scales, as in the Pierids.

There are various ways in which melanism may be caused:—(1) The contained pigment may be greater in quantity; (2) it may be more strongly oxidised, which darkens it; (3) where there are both light and dark scales the latter may increase in number; (4) the scales may become so numerous as to overlap each other, and thus reinforce the darkness; (5) the scales may be enlarged, which increases the overlapping; (6) dark hairs may increase in number—like the scales, these are susceptible of change in their colouring matter; (7) one face of the wing may appear darker if, owing to the small quantity of pigment in its scales, the darker opposite face of the wing shows. Converse considerations apply to the causation of albinism; as regards (5), a very frequent cause, the scales may so diminish in size that instead of overlapping they scarcely touch, and leave empty spaces; they may diminish in size on both sides of the wing, which thus becomes transparent. (6) They may curl up at the sides, producing similar consequences to those numbered (4) and (5).

There is a very interesting chapter on cases where the optical and the pigmentary effects are combined. Green in the Pierids is not caused by green pigment, but by a mixture of yellow and black scales having *reflets bleus*; and in *V. io* the violet and green is caused by red and yellow scales mixed with white scales having *reflets bleus*.

The cause of variation may be generally stated thus. An individual which in the course of its ontogeny makes less pigment than its congeners, albinises; inversely, it melanises if it makes more pigment than is normal; the quantity of pigment

[1] "Recherches Expérimentales sur les Mécanismes du Mélanisme et l'Albinisme chez les Lépidoptères." By Dr. Arnold Pictet. Mémoires de la Société de Physique et d'Histoire naturelle de Genève, vol xxxvii. Pp. 111–278+5 plates. (Genève: George & Cie.; Paris: G. Fischbacher. 1912.)

is much more important than chemical modification of it.

The author states that his researches confirm in some measure a fact which seems general among animals, viz. that melanism is a sign of vigour and health; albinism, on the contrary, of the enfeebling of the organism. In melanism we have great abundance of pigment, increase in the size of scales and sometimes in their number, usually greater size, the females generally with voluminous abdomen, full of eggs: among Bombyces a great increase in pilosity. In albinism, on the other hand, we have the opposite state of things; the scales also frequently deformed, curled, and atrophied, the wings often failing to develop, the abdomen slender, with few eggs or none; in the Bombyces little pilosity.

The author refers to Standfuss's hypothesis that this enfeebling may begin in the larva, and to his own experiments supporting this. Caterpillars ill-nourished, having been supplied with leaves they could ill bite into, produced imagines struck with albinism, supporting the view that albinism is a sort of anæmia of the organism. These modifications increase in succeeding generations subjected to similar conditions, but at the end of four generations the caterpillars adjust themselves to the leaves they found difficult, and then recover their vigour, size, and habitual colour. There are certain characters which exposure to abnormal conditions does not seem able to modify, such characters as are common to a group or genus, for instance, the discoidal spot of *L. quercus*, and the discoidal V. of *Ocneria dispar*.

Dr. Pictet's valuable researches certainly cannot be considered to exhaust the subject of the cause of variation in the colouring of lepidoptera. In the case of seasonally dimorphic species, for example, experiments seem to have shown that the difference in colouring is dependent more on the differential life habit of the spring and summer emergences than on mere exposure to environment or change of environment. With many lepidoptera long duration in the pupal stage, such as is produced by a low temperature, usually causes darkness, but in *A. levana* cooling the summer pupa for many months results in an imago so much brighter than the nearly black imago which comes from a pupal life in a summer temperature of five or six days that it looks quite a different species.

F. MERRIFIELD.

THE SENSITIVENESS OF SELENIUM TO LIGHT OF DIFFERENT COLOURS.

SOME curious facts about the behaviour of the selenium cell are mentioned in a recent paper by A. H. Pfund.[1] The possibility of using these cells for ordinary photometric processes has often been discussed, but there are certain irregularities in their behaviour which set a limit to their usefulness.

One obvious difficulty lies in the fact that the rays of light to which the eye is most sensitive are not necessarily those which have the most effect on selenium. Pfund brings this out by reproducing—what has seldom been published before—a curve showing the distribution of sensitiveness of this material throughout the spectrum of a Nernst filament. The energy-maximum in this spectrum lies far out in the infra-red; the maximum luminosity to the eye (at moderate illuminations) is situated in the yellow-green. The maximum sensitiveness of selenium, however, is located in the red, and the shape of the curve is also distinctly different from the luminosity curve for the eye, so that inconsistent results would evidently be obtained if one tried to compare the light from various illuminants (having radically different energy-curves) by means of the selenium cell. But it may be mentioned that, according to a recent number of *The Illuminating Engineer*, such cells have a possible sphere for purely comparative measurements of one and the same illuminant; for example, they have been used for studying the fluctuations in daylight and the variation in illumination in the course of an eclipse.

Perhaps the most curious point brought out in these researches is the dependence of the maximum sensitiveness of the selenium cell on the intensity of the stimulus. With a very bright light the maximum is in the red, near $0{\cdot}7\,\mu$. But as the illumination is weakened, this maximum becomes less definite, and ultimately, in a feeble light, another maximum point, situated about $0{\cdot}57\,\mu$, appears. Ruhmer makes two kinds of selenium cells. The "hard" type is most sensitive to strong light, but relatively insensitive to feeble stimuli, and has its maximum in the red. The "soft" type, on the contrary, is most sensitive to weak light, and has its maximum in the green. This explains the discrepancies between earlier observers, some of whom found selenium to be most sensitive to yellow light, while others thought that red had most effect.

Now the interesting point to observe here is that this behaviour of the selenium cell is curiously similar to that of the eye. It is a well-authenticated fact, demonstrated many years ago by Sir Wm. Abney, that whereas at strong illuminations the maximum luminosity occurs near $0{\cdot}58\,\mu$ in the yellow, in weak light it shifts to the green, probably near $0{\cdot}51$–$0{\cdot}53\,\mu$. This is known as the Purkinje effect. In very feeble light the eye seems almost insensitive to red, while green and blues appear an uncanny light grey. Formerly this singular effect was ascribed to a struggle for predominance between the minute light-perceptive organs on the retina known as the "rods" and "cones." But, according to a later theory, this is not necessarily so, for the accentuation of the red end of the spectrum with increasing stimuli is characteristic of all photo-chemical processes.

At all events the similarity between the eye and the selenium cell in this respect is very suggestive. At first sight this complicated behaviour of selenium would seem unfavourable to

[1] *Phys. Review*, xxxiv., No. 5, May, 1912.

its extended use in photometry. But in a sense it appears fortunate, since it suggests that one might conceivably prepare selenium in such a way as to follow out almost exactly the behaviour of the eye as regards the perception of luminous energy.

NOTES.

THE typhoon which recently visited Japan, isolated Tokyo telegraphically from September 22 to 24, and carried widespread devastation, is said to have been the severest experienced in half a century. Accounts so far are meagre, but according to reports already received the loss of life and damage to property afloat and on shore are appalling. The storm appears to have been most violent in the middle of the south coast. Typhoons are revolving storms of tropical origin that may occur in Far Eastern seas—the North Pacific or the China Seas—during any month of the year. In Japan and its neighbourhood they are, as a rule, confined to the months of June to September inclusive, and are most frequent in September. In general, all tropical revolving storms follow a parabolic track. The typhoons that visit Japan in September usually originate in the Pacific south-eastward of Formosa, move N.W. by W., recurve when abreast of that island, and then take the direction of the Japan Sea. Algué divides the tracks of typhoons in the Far East into two classes—those of the Pacific, which do not cross the meridian of 124 E., and those of the China Sea. A typhoon is said to travel rapidly when its rate of motion exceeds twelve nautical miles an hour; if its rate of motion be less than six miles an hour it is said to travel slowly. The September typhoons come under the former category.

DURING the recent meeting at Geneva of the fourteenth International Congress of Prehistoric Anthropology and Archæology, an important piece of work was carried out by the Committee for the Unification of Anthropometric Measurements. The committee (or commission) included representatives of most of the European countries, as well as of the United States of America, and the number amounted to about thirty. Dr. Duckworth (of the Cambridge Anthropological Laboratory) was one of the three secretaries appointed to prepare a report of the proceedings. The secretaries made out a report, which was adopted at the final meeting of the commission, and was confirmed at the concluding meeting of the congress. The official report will be published in French, but it is intended to issue translations in English and in German simultaneously, if possible, with the official version. The illustrations are to be uniform in all three publications. Dr. Duckworth is at present engaged (for the third year in succession) upon excavations at Gibraltar, but he will be pleased to give further information as to the above-mentioned report after his return to England early this month. Communications should be addressed to the Anthropological Laboratory, New Museums, Cambridge.

A CONFERENCE of members of the Museums Association and of others interested in similar work will be held on the afternoon of Thursday, November 7, at the Manchester Museum, for the purpose of discussing subjects of common interest to those concerned in the work of museums, art galleries, and kindred institutions.

THE Huxley lecture will be delivered at Charing Cross Hospital Medical College on Thursday, October 31, by Prof. Simon Flexner, of the New York Rockefeller Institute, on "Recent Advances in Science in relation to Practical Medicine." On the same day the extensive new laboratories of public health and bacteriology, recently formed by the school and taken over by the University of London as the public health and bacteriological departments of King's College, will be formally opened and handed over to the University.

ON the suggestion of Mr. Mark Sykes, M.P., Sir Tatton Sykes has kindly sent for exhibition in the Hull Museum the objects of prehistoric date in his possession. These include the contents of the famous Duggleby Howe burial mound, which contained flint and bone weapons and implements of exceptional interest; a prehistoric jet necklace containing several hundred beads; a fine series of prehistoric implements in flint, sandstone, bronze, &c., and some earthenware vases taken from British burials on the Yorkshire Wolds.

THE extensive collection of east Yorkshire and north Lincolnshire diatoms, made by the late R. H. Philip, of Hull, also the specimens which have been figured and described in the well-known work by Mills and Philip, together with his microscope, a fine collection of microscopical slides (including several made by Robt. Harrison, a former Hull microscopist), and his scientific books, have been presented by Mrs. Philip and family to the Hull Museum. The collection of slides contains more than 3000 specimens, and among the books are such important works as "Diatomées Marines de France," by MM. H. et M. Peragallo; "A Treatise on the Diatomaceæ," by Van Heurck; "Diatomaceæ Germaniæ," by H. von Schonfeldt; "British Desmidiaceæ," by W. West, and numerous other volumes dealing with microscopy.

THE British Fire Prevention Committee opened its autumn session on September 25 with two important series of official fire tests, namely, (1) a series of twenty tests with ordinary celluloid kinematograph films *versus* a non-inflammable celluloid film; and (2) an extensive series of some twenty-five fire tests as to the possibility of extinguishing petrol fires, celluloid fires, and similar outbreaks by the application of chemical foam. Reports upon the tests, which were witnessed by representatives of about thirty Government departments and other institutions, will be published by the committee later.

THE next meeting of the Australasian Association for the Advancement of Science is to be held at Melbourne in the University, from January 7 to 14, 1913, under the presidency of Prof. T. W. E. David, C.M.G., F.R.S., Sydney. The presidents of the various sections are as follows:—A, Astronomy, Mathematics, and Physics, Prof. H. S. Carslaw, Sydney; B, Chemistry, Prof. C. Fawsitt, Sydney; C, Geology and Mineralogy, Mr. W. Howchin, Adelaide; D, Biology, Prof. H. B. Kirk, Wellington, N.Z.; E, Geography and History, Hon. Thos. M'Kenzie, Wellington, N.Z.; F, Ethnology and Anthropology, Dr. W. Ramsay-Smith, Adelaide; G1, Social and Statistical Science, Mr. R. M. Johnston, Hobart; G2, Agriculture, Mr. F. B. Guthrie, Department of Agriculture, N.S.W.; Subsection, Veterinary Science, Prof. Douglas Stewart, Sydney; H, Engineering and Architecture, Colonel W. L. Vernon, Sydney; I, Sanitary Science and Hygiene, Dr. T. H. A. Valintine, Wellington, N.Z.; J, Mental Science and Education, Sir J. Winthrop Hackett, K.C.M.G., Perth, W.A. In addition to the meetings of the sections, arrangements are in progress for evening lectures and entertainments, and for excursions to places of interest. Full particulars can be obtained from the permanent hon. secretary, Mr. J. H. Maiden, Botanic Gardens, Sydney. The hon. treasurer for the Melbourne meeting is Mr. G. H. Knibbs, C.M.G., Melbourne, and the general secretary Dr. T. S. Hall, University, Melbourne.

Dr. W. E. Garforth has recently presented to the University of Leeds and placed in the geological department a large case containing specimens which show the structures of numerous seams of coal from Yorkshire, Lancashire, Staffordshire, and Australia. The lower part of the case contains coal-balls, or bullions, which are found in the Halifax Hard Bed of Yorkshire and its equivalent, the Bullion Mine, in Lancashire. The coal-balls are simply masses of vegetable material which were impregnated with calcium carbonate while the tissues were still in a fresh condition, and so preserved during the subsequent changes which the surrounding vegetable matter underwent in the process of its conversion into coal. Many of the microscopic sections of these coal-balls are of an extraordinary size, measuring 8 in. by 6 in., and show the structure of the plants most beautifully. The centre of the case is occupied by a series of models illustrating the structure of Lepidostrolius, the "fruit" of Lepidodendron and its allies, showing the position of the megasporangia and microsporangia. Perhaps the most interesting sections are those from coal seams in which explosions have occurred, such as those from No. 3 Bank Pit, Atherton, near Bolton. These were prepared with the view of ascertaining whether any connection could be traced between the microscopic structure of the coal and the character of the coal dust, and were the first sections to be prepared for that purpose. The whole of the sections were made by the Lomax Palæobotanical Co., Bolton, and the case was exhibited at the Franco-British Exhibition.

In *L'Anthropologie* for June-July-August, MM. C. Maska, H. Obermaier, and H. Breuil describe a remarkable discovery of an ivory statuette of a mammoth found near the village of Prerau, not far from the battlefield of Austerlitz. This site has already supplied a vast number of remains of extinct animals and flint implements of the palæolithic period. The present figure measures 116 mm. in length and 96 mm. in breadth. It represents the animal with full details of head and trunk. It is referred to the Salutrian Age, and is thus much older than the carvings of the animal in the flat from La Madelaine, Combarelles, Font-le-Gaume, and Pindal in Spain, of which drawings for the purpose of comparison are supplied in the article. This is the finest representation hitherto found of this great beast which flourished for ages in the steppes and prairies of ancient Europe, and was hunted for food by its early races.

The *National Geographic Magazine* for July devotes one of its usual well-illustrated articles to an exploration of the little-known parts of Panama by Mr. H. Pitter. The Guaymies, one of the aboriginal tribes, who were formerly under the influence of Roman Catholic missionaries, have now reverted to their ancient customs and manner of life. Among the Suna-Cunis, while some of the men have visited the United States and Nova Scotia, and have thus acquired some degree of culture, primitive habits are perpetuated among the women, who have not as yet been allowed a glimpse of the outer world. The article, as a whole, gives an instructive picture of the gradual acquirement of a new phase of culture in its varied forms.

In the report of the Warrington Museum for the year ending June 30, the director and librarian records some progress in all departments, but no change in the programme, of that institution.

In an article on type-specimens, published in the August number of *The Victorian Naturalist* (vol. xxix., p. 59), Mr. F. Chapman proposes the new term "tectotype" for specimens, fragmentary or otherwise, selected to illustrate the external or internal microscopic characters of a species or genus. Such a specimen may be the section of a tooth, a flake of a shell, a slice of a foraminifer, or a preparation from a fossilised leaf.

Prof. W. L. McAtee commences a long article in the Proceedings of the Philadelphia Academy for June on the experimental method of testing the efficiency of warning and cryptic coloration in protecting animals from their enemies by the statement that the theories on this subject long preceded any knowledge of the food-preferences of insectivorous species sufficient to justify such speculations. At the conclusion he states that the behaviour of animals in captivity, as regards food, does not afford trustworthy indications of what they would do in the wild state when offered similar food, thereby showing that the results of such experiments do not indicate the parts the animals might play in natural selection. He therefore urges that the time expended in making such experiments might be better employed in collecting trustworthy data in regard to the food-habits of animals in the wild condition, as "the result would be truth, not imaginative inferences from abnormal behaviour."

It is a well-known fact that in certain aquatic hemipterous insects belonging to the genera Zaitha and Serphus, the females—in Europe, Japan, the West Indies, and America—are in the habit of attaching their eggs to the backs of their apparently unwilling partners, in such a manner as to form a complete coating. According to an article by Prof. J. F. Abbott in the September number of *The American Naturalist*, a somewhat analogous, although more remarkable, instance of abnormal "nursery arrangements" occurs in the case of a North American hemipterous insect (*Rhamphocorixa balanodis*) belonging to the family Corixidæ, which is related to the Notonectidæ, as represented by the well-known "water-boatman." In 1910 it was observed that many of the crayfish (*Cambarus immunis*) near Colombia, Mo., were more or less completely coated with the eggs of this insect, each egg being imbedded in a small cup fixed to the shell of the crayfish. Each crayfish carried hundreds of eggs, and as each female Rhamphocorixa lays comparatively few, several insects must have cooperated in investing the crayfish. It is suggested that the coating of eggs renders the crayfish less conspicuous than in its ordinary condition, just as crabs carrying colonies of algas, sponges, or sea-anemones probably profit in some manner by the investiture.

We have received from Dr. Friedrich König, of Krailling-Planegg, near Munich, a small pamphlet on the reconstruction of extinct vertebrate animals, with photographs of models which he has prepared in accordance with the principles he explains. He emphasises especially the important aid afforded by the new kinematograph films of wild animals in motion, and points out how much less hypothetical are restorations made with our present knowledge than those which were attempted some years ago. His pamphlet forms an interesting summary of the whole subject, its problems and difficulties, with full references to all the important literature. Among his own restorations that of Diplodocus is particularly striking, for he has tried to avoid the appearance of a sleek pachyderm by assuming the presence of a series of glands beneath the skin, which give the dorsal region of the body a segmented aspect.

In the September number of *The American Journal of Science* Prof. Roy L. Moodie publishes a detailed description of the remains of *Eobatrachus agilis* from the Upper Jurassic of Wyoming, U.S.A., and confirms the opinion of the late Prof. O. C. Marsh that they represent a true anourous amphibian. Prof. Moodie finds that the bones are closely similar to those of a modern toad, and he comments on the great interest of the discovery of so highly specialised an animal in rocks so ancient as those of the Jurassic period. He overlooks the fact, however, that a well-preserved skeleton of a frog, *Palaeobatrachus gaudryi*, is already known from the Upper Jurassic of northern Spain (L. M. Vidal, *Mem. Real Acad. Ciencias de Barcelona*, vol. iv., No. 18, 1902).

The Rev. M. Saderra Masó, the well-known student of the Philippine earthquakes, finds that most of the earthquakes in southern Luzon originate along three great fractures, two of which lie to the east and west of the island, and are roughly parallel to the coast-lines, while the third, and most important, traverses the Taal volcano (the seat of the disastrous eruption of 1911), and runs in a north-north-easterly direction, passing some miles to the east of Manila. The earthquakes which originate in the south-western part of this line are characterised by relatively long duration and rather slow undulations of large amplitude, while those which proceed from the north-eastern part of the fracture are more dangerous, owing to the rapidity of their vibrations. It is in the latter part of the fracture that the destructive earthquakes of Manila have for the most part originated.

All the available space in *Symons's Meteorological Magazine* for September is devoted by Dr. Mill to an account and preliminary map of the distribution of rain in East Anglia on August 26 and 27, which was altogether unprecedented for a cyclonic storm in that part of Great Britain. The relation of the track of the depression to the rain area was similar to that of the great Irish fall of August 24–26, 1905 ("British Rainfall," pp. [110]–[114]). On the morning of August 26 the Daily Weather Report issued by the Meteorological Office showed a depression off the North Foreland; by 6 p.m. it had moved northwards and deepened off the most easterly part of the Norfolk coast, and during the night turned to the right, across the North Sea. The storm seems to have been central close to Norwich, and the area of torrential rain lay in the north-east of Norfolk. The more important facts relating to the heavy rainfall are given in letters from several of Dr. Mill's staff of observers. Among these Mr. J. H. Willis, of Norwich, took the trouble to read his gauge twelve times between 4 a.m. of August 26 and 4 a.m. of August 27; he recorded 6·32 in. in the twelve hours to 4 p.m. of August 26, and a further inch exactly in the following twelve hours. Only 0·04 in. fell between 4 and 9 a.m. on August 27, making 7·36 in. in twenty-nine hours. Although the twenty-four hours in question do not count as a "rainfall day" (twenty-fours ending at 9 a.m.), and the amount does not compare with other falls, it has not been surpassed in the British Isles on more than two or three occasions. The remarkable amount of 8·09 in. was recorded at Brundall, five miles east of Norwich, for the two days. Dr. Mill computes that the county of Norfolk, with an area of 2044 square miles, had a general rainfall of probably 4·88 in., which would be equivalent to twice as much water as is contained in Windermere, the largest of the English lakes.

The Journal of the Franklin Institute for September contains an account of some experiments on the electrical precipitation of solid and liquid matter suspended in gases by Mr. W. W. Strong, of the department of industrial research of the University of Pittsburg. The suspended matter was obtained by blowing lime dust or the smoke produced by burning soft coal or the spray from a nozzle through which alcohol, ether, or toluol was forced, into the space between an earthed electrode and one connected to six different types of high-tension apparatus. The experiments show that the problem of precipitating smoke is identical with that of removing dust, and that the coronal discharge is much more effective than the brush discharge, especially with large velocities of the gas containing the suspended particles. With this type of discharge the size of the precipitating chamber may be materially reduced. The ionic currents due to secondary ionisation appear to play a more important part in the process than has been supposed.

In an interesting note in the *Gazzetta chimica italiana* (vol. xlii., ii., 85) by F. Calzolari, the relationship between solubility and electro-affinity is discussed with especial reference to the chlorates and perchlorates of the alkali-metals, potassium, rubidium, and cæsium. According to the electrochemical theory of Abegg and Bodländer, the solubility should diminish, in the case of these salts, as the atomic weight of the metal increases, so that the solubility of the rubidium salts should be intermediate between the solubilities of those of potassium and cæsium; actually, however, it was found that at 20° the solubility of the cæsium salts is intermediate between those of the potassium and rubidium compounds, whilst, owing to the crossing of the solubility curves at higher temperatures, the order of the arrangement is entirely different at different temperatures. The case is apparently similar with the nitrates. The solubility of these salts, which has been cited in favour of the theory of electro-affinity, is in reality not in accord with it.

The Biochemical Journal, vol. vi., part 3, contains an important paper by Messrs. E. S. Edie, W. H. Evans, B. Moore, G. C. E. Simpson, and A. Webster from the laboratories of biochemistry and tropical medicine of the University of Liverpool, on the question of the cause and curative treatment of beri-beri and polyneuritis. An alcoholic extract of ordinary yeast, after removal of the alcohol at a low temperature, is extremely active in curing the convulsions and lameness of birds suffering from polyneuritis. An organic base, to which the name *torulin* has been given, has been isolated from this extract; its nitrate has apparently the composition, $C_7H_{16}O_2N,HNO_3$, forms feathery crystals, and is not precipitated by basic lead acetate, although thrown down by phosphotungstic acid. The alcoholic yeast extract loses its activity on warming, and the active substance is apparently easily destroyed by heat. Experiments are in progress to ascertain whether birds can fully maintain their weight and activity on a diet of polished rice, which ordinarily produces neuritis, when taken in conjunction with small doses of torulin; or whether it will only prevent the onset of convulsions or nervous changes without being able to maintain full nutrition.

The Builder for September 27 gives some interesting particulars of ancient iron beams in India. At the Black Padoga of Orissa, Kanarak, there are some very large forged iron beams; the two largest members, as described by Mr. H. G. Graves, of Calcutta, are 35 ft. long by 8 in. square, and 25·5 ft. long by 11 in. square. The broken end of one of them indicates that the method of construction was by the welding up of billets. The age of the temple has been placed by some as early as the ninth, and by others as late as the thirteenth, century. Examination indicates that the small blooms were of 3 to 4 lb. in weight; in some places the blooms appear to have been welded together in strings to form short bars, which in turn were welded into place. No special care seems to have been taken to make the blooms break joint. The beams are nearly all of uniform size, and square in section from end to end. The designers do not appear to have understood the advantage of making the depth of the beam greater than the width. The beams could have been of but little structural value, although they constitute interesting examples of smiths' work.

Commenting on Sir W. H. White's address at the recent International Mathematical Congress, *Engineering* for September 27 states that it is not a little remarkable how little information mathematics is able to give us as to the strength of any engineering structure. In many cases, the service which mathematics renders is to furnish laws of comparison by which, without knowing the actual limits of the stresses, we can conclude that a structure which has successfully met certain conditions may be used as a basis for designing another similar structure, larger or smaller, to meet similar conditions. Perhaps the greatest service that mathematics can render to the engineer is in directing the course of a series of experiments and in analysing the results observed. There is unquestionably an immense mass of data uselessly pigeon-holed in the archives of manufacturing firms simply and solely because their technical staff are insufficiently equipped with mathematical knowledge to analyse these records effectively, and the art of the engineer and the profits of the manufacturer suffer in consequence.

Messrs. John Bartholomew and Co., of the Geographical Institute, Edinburgh, have published two additional sheets to their "half-inch to mile" map of Scotland. One sheet deals with Berwick and Haddington, the other with Inverness and Spey. The familiar greens and browns associated with this excellent series of reduced survey maps serve admirably to bring out the build of the country depicted, and the points of the compass arranged to show the magnetic variation, with the annual decrease of the variation indicated, is a commendable feature which will be of great assistance to tourists using the map with a compass. The price of the sheet on paper is 1*s*. 6*d*., and on cloth 2*s*.

Several additions have recently been made to the "Home University Library of Modern Knowlege" and to "The People's Books." Messrs. Williams and Norgate have added to the former series, among other volumes, the following books: "The Human Body," by Prof. Arthur Keith, "Electricity," by Prof. Gisbert Kapp, and "The Making of the Earth," by Prof. J. W. Gregory, F.R.S. To "The People's Books" Messrs. T. C. and E. C. Jack have added, with others, the following volumes: "The Evolution of Living Organisms," by Mr. E. S. Goodrich, F.R.S.; "Embryology," by Dr. Gerald Leighton; "Practical Astronomy," by Mr. Hector Macpherson, Jun.; and "Aviation," by Mr. S. F. Walker. It may be hoped that the recent rapid growth of scientific literature for the general reader is an indication of a fuller understanding of the important part which science must take in the work and development of modern States.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR OCTOBER :—

Oct. 3. 18h. 0m. Mercury in superior conjunction with the Sun.
4. 9h. 25m. Neptune in conjunction with the Moon (Neptune 5° 46′ S.).
9. 3h. 0m. Uranus stationary.
10. 2h. 0m. Sun eclipsed, invisible at Greenwich.
,, 11h. 36m. Mercury in conjunction with the Moon (Mercury 1° 35′ N.).
,, 17h. 10m. Mars in conjunction with the Moon (Mars 1° 44′ N.).
12. 4h. 6m. Venus in conjunction with the Moon (Venus 2° 52′ N.).
13. 16h. 51m. Mercury in conjunction with Mars (Mercury 0° 11′ S.).
14. 6h. 15m. Jupiter in conjunction with the Moon (Jupiter 5° 2′ N.).
17. 22h. 40m. Uranus in conjunction with the Moon (Uranus 4° 35′ N.).
19. 6h. 0m. Neptune at quadrature to the Sun.
22. 21h. 0m. Uranus at quadrature to the Sun.
27. 23h. 9m. Saturn in conjunction with the Moon (Saturn 6° 26′ S.).
31. 15h. 12m. Neptune in conjunction with the Moon (Neptune 5° 43′ S.).

GALE'S COMET 1912*a*.—Dr. Ebell's elements and an extended ephemeris for comet 1912*a* appear in No. 4602 of the *Astronomische Nachrichten*.

Ephemeris 12h. (M.T. Berlin).

1912	α (true) h. m.	δ (true) ° ′	log r	log Δ
Oct. 3	15 24·0	−3 34·3		
5	15 28·6	−1 10·7	9·8616	0·0301
7	15 32·7	+1 7·4		
9	15 36·5	+3 20·2	9·8653	0·0454
11	15 40·0	+5 27·5		
13	15 43·1	+7 29·6	9·8740	0·0600

The calculated magnitude remains about 5·0 until the middle of October, so that given a good clear horizon the comet should not be a difficult object for field glasses, or even the naked eye; during the current week it should be looked for almost due west. On October 5, at about 7.30 p.m., it will lie about halfway between β Libræ and α Serpentis, and will form the apex of an isosceles triangle, having the base, α Coronæ Arcturus, about two-thirds the length of the side. Its apparent path lies nearly along the line joining β Libræ to a point one-third the distance from α to ε Serpentis, a point which it will pass on October 11. As may be seen from the ephemeris, the comet's distance from the sun increases after October 5, and its distance from the earth is also increasing, so that it will not become any brighter; at perihelion passage, October 5, it will be some 67·5 million miles from the sun, and 99·4 million from the earth, while on October 13 these distances will be 69·5 and 106·7 million miles respectively. The orbit of this comet is peculiar by reason of its great inclination, 82°, to the ecliptic.

EPHEMERIS FOR TUTTLE'S COMET.—In No. 4602 of the *Astronomische Nachrichten*, M. N. Miličević gives an ephemeris for Tuttle's comet, based on the elements, uncorrected for perturbations, published in No. 3552 of the same journal. According to this ephemeris, the comet should now be high up in Ursa Major (October 6, α=8h. 36m., δ=+76° 19′), and should travel southwards to α=10h. 8m., δ=70° 24·7′ on October 31. Its calculated distances from the sun and earth on October 6 are 153 and 123 millions of miles respectively. Discovered by Méchain in 1790, this comet was rediscovered by Tuttle in 1858, and, having a period of about 13·7 years, was seen again in 1871, 1885, and May, 1899, so that it should pass perihelion some time early next year.

THE LATITUDE OF THE KHEDIVIAL OBSERVATORY AT HELWAN.—Some interesting facts concerning latitude determinations are brought to light in a paper published by Messrs. Wade and Knox Shaw in Bulletin No. 6 of the Khedivial Observatory, Helwan. The observations discussed were made (1) because observations made in September, 1908, gave a value for the latitude 3″ lower than that formerly accepted, and (2) because the observations at other geodetic stations suggested a night-to-night variation, possibly due to some atmospheric variation such as the shifting of the refractive zenith. They were also intended to show whether any abnormal variation of latitude took place from month to month.

The instruments and observations are fully discussed, Talcott's method having been employed, and the final value for the latitude of the geodetic pillar is given as 29° 25′ 31·82″ N. ±0·11″. The authors conclude that there is no very definite evidence for a night-to-night variation, but there seems to be a variation from month to month; thus August, 1911, shows the largest residual, +0·92″, from the mean value, although the probable error of the determination is small. August, 1910, also gave an abnormal value, and during the period July, 1910, to August, 1911, the mean latitude actually varied from 31·67 to 32·1″.

THE MANCHESTER ASTRONOMICAL SOCIETY.—The report of this society shows that a vigorous interest in astronomy is exhibited in the Manchester district, an interest which would be welcome in other centres. The membership for 1910–11 was 128, as compared with 98 in 1903–4, and the average attendance at the meetings was 72. Many interesting papers were read and discussed, the lecturers including Father Cortie and Mr. T. Thorp. On alternate Wednesdays the Godlee Observatory is open to members for practical work.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

A. and C. Black.—Ranching in the Canadian West, A. B. Stock. *Blackie and Son, Ltd.*—Woman's Place in Rural Economy, translated from the French of Paul de Vuyst. *C. Griffin and Co., Ltd.*—A Manual of Practical Agricultural Bacteriology, Prof. F. Lohnis, translated by W. Stevenson and J. H. Smith, illustrated: The Laboratory Book of Dairy Analysis, H. D. Richmond, new edition, illustrated. *T. Werner Laurie, Ltd.* Farm Dairying, L. Rose *Longmans and Co.*—English Farming Past and Present, R. E. Prothero. *Macmillan and Co., Ltd.*—The Beginner in Poultry, C. S. Valentine, illustrated; Sheep Farming, J. A. Craig and F. R. Marshall; Forage Crops for the South, S. M. Tracy, illustrated. *John Murray.*—Practical Agricultural Chemistry, Dr. S. J. N. Auld and D. R. Edwardes-Ker, illustrated. *John Wiley and Sons (New York).* Dairy Technology, Prof. C. Larsen and W. White.

ANTHROPOLOGY.

The Cambridge University Press.—The Civilization of Ancient Mexico, L. Spence. *Gustav Fischer (Jena).*—Der Derfflinger Hügel bei Kalbsrieth (Grossherzogtum Sachsen), A. Möller. *Macmillan and Co., Ltd.*—The Golden Bough: a Study in Magic and Religion, Prof. J. G. Frazer, third edition, revised and enlarged: Part vi., The Scapegoat;

Part vii., Balder the Beautiful; Marriage Ceremonies in Morocco, Prof. E. Westermarck; The Pagan Tribes of Borneo: a Description of their Physical, Moral and Intellectual Condition, with some Discussion of their Ethnic Relations, Dr. C. Hose and Dr. W. M'Dougall, F.R.S., 2 vols., illustrated. *Seeley, Service and Co., Ltd.*—Among Congo Cannibals: the Experiences, Impressions, and Adventures during a Thirty Years' Sojourn among the Boloki and other Congo Tribes, with a Description of their Curious Customs, Habits, and Religion, J. H. Weeks, illustrated.

BIOLOGY.

Edward Arnold. The Life of an Elephant, Sir S. Eardley-Wilmot, K.C.I.E., illustrated. *A. and C. Black.*—First Principles of Evolution, Dr. S. Herbert, illustrated; Coarse Fishing, H. T. Sheringham, illustrated; Life-history and Habits of the Salmon, Sea-trout, Trout, and other Freshwater Fish, P. D. Malloch, new edition, illustrated; Peeps at Nature, edited by Rev. C. A. Hall: British Ferns, Club-mosses, and Horse-tails, D. Ferguson, illustrated; Natural History of the Garden, W. P. Westell, illustrated. *Blackie and Son, Ltd.*—Plant Diseases, Dr. W. F. Bruck, translated. Edited by Prof. J. R. Ainsworth Davis. *The Cambridge University Press.*—The Genus Iris, W. R. Dykes, illustrated; Makers of British Botany, Prof. F. W. Oliver; The Vegetation of the Peak District, Dr. C. E. Moss; Herbals, Dr. Agnes Arber, illustrated; *Cassell and Co., Ltd.*—British Birds' Nests: How, Where, and When to Find and Identify Them, R. Kearton, new edition, illustrated; The Charm of the Hills, S. Gordon, illustrated; Insect Workers, W. J. Claxton, illustrated. *J. M. Dent and Sons, Ltd.*—Plant Geography, Prof. G. S. Boulger. *A. C. Fifield.*—The Nature of Woman, J. L. Tayler, with a supplementary chapter on Landmarks in the Subject, containing an article "Woman," by W. C. Roscoe; The Forest Farm: Tales of the Austrian Tyrol, P. Rosegger, with a biographical sketch by Dr. J. Petersen, an appreciation by M. E. King, a photograph of Rosegger, and a sketch of his forest home; The Soul of a Gardener, H. M. Waithman. *Gustav Fischer (Jena).*—Vorlesungen über technische Mycologie, Dr. F. Fuhrmann; Richtlinien des Entwicklungs- und Vererbungsproblems, Dr. A. Greil, Zweiter Teil: Anpassung und Variabilität, Ererbung und Erwerbung, Geschlechtsbestimmung (Entwicklungs- und Vererbungstheorien); Die Gattung Hedera, F. Tobler, illustrated. *R. Friedländer und Sohn (Berlin).*—Études de Lépidoptérologie comparée, C. Oberthür, Fasc. vi., illustrated; Katalog der paläarktischen Hemipteren, B. Oshanin (Heteroptera, Homoptera-Auchenorhyncha und Psylloideæ); Résultats des Campagnes Scientifiques d'Albert I., Prince de Monaco, Fasc. xxxv., Poissons des camp. 1901–10, E. Zugmayer, illustrated; Fasc. xxxvi., Géphyriens des camp. 1898–1910, G. P. Sluiter, with coloured plate; Das Tierreich, edited by F. E. Schulze: Lief. 34, Amathusiidae, H. Stichel; Lief. 35, Rhabdocoela, L. v. Graff; Lief. 36, Pteropoda, J. J. Tesch; Verhandlungen des V. Internationalen Ornithologen-Kongress, Berlin, 1910, edited by H. Shalow, illustrated; Zoologischer Jahresbericht für 1911; Chromotaxia seu Nomenclator Colorum Polyglottus ad usum Botanicorum et Zoologorum, Prof. P. A. Saccardo, new edition, illustrated; Die Fauna der Deutschen-Kolonien, Reihe v., Heft 3, Drs. G. Aulmann and W. La Baume, illustrated; Ornis Romaniae, Die Vogelwelt Rumaniens, R. v. Dombrowski; Die sanitärisch-pathologische Bedeutung der Insecten u. verwandten Gliedertiere, namentlich als Krankheitserreger u. Krankheitsüberträger, Prof. E. A. Goeldi, illustrated; Die Planarien des Baikal-Sees (Tricladen), Prof. A. Korshieff, illustrated; Die Birkhühner Russlands, Bastarde und Varietäten, T. Lorenz, 4 parts, illustrated. *W. Heffer and Sons, Ltd. (Cambridge).*—British Violets: a Monograph, Mrs. E. S. Gregory, illustrated. *Henry Holt and Co. (New York).*—The Living Plant, Prof. W. F. Ganong, illustrated. *T. C. and E. C. Jack:*—Present-day Gardening, edited by R. H. Pearson: Tulips, Rev. J. Jacob; The Rock Garden, R. Farrer; Dahlias, G. Gordon, each illustrated; The Science of Life, Prof. W. D. Henderson; Animal Life, Prof. E. W. MacBride, F.R.S.; Bacteriology, Dr. W. E. C. Dickson; Darwin, Prof. W. Garstang. *C. H. Kelly.* British Fern Varieties, F. G. Heath, illustrated; Nature's Nursery Tales, S. N. Sedgwick, illustrated. *Longmans and Co.*—South African Snakes and their Venom, and how to Treat Snake Bite, F. W. Fitzsimons, new edition, illustrated; A Text-book of Practical Bacteriology and Microbiology, Dr. A. Besson, translated from the fifth French edition, and adapted by Prof. H. J. Hutchens. *Macmillan and Co., Ltd.*—A Treatise on Embryology, edited by W. Heape, F.R.S.: Vol. i., Invertebrata, Prof. E. W. MacBride, F.R.S., illustrated; Physiological Plant Anatomy, Prof. G. Haberlandt, translated by J. M. F. Drummond, illustrated; The Cotton Plant in Egypt: Studies in Genetics and Physiology, W. L. Balls, illustrated; The Marine Mammals in the Anatomical Museum of the University of Edinburgh, Part i., Cetacea, Part ii., Sirenia, Part iii., Pinnipedia, Sir Wm. Turner, K.C.B., F.R.S., illustrated; Injurious Insects: How to Recognise and Control Them, Prof. W. C. O'Kane, illustrated; Trees in Winter, Prof. A. B. Blakeslee, illustrated. *John Murray.*—The Big Game of Central and Western China, H. F. Wallace, illustrated.—Problems of Life and Reproduction, Prof. M. 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CLIMATOLOGICAL OBSERVATIONS.

A VALUABLE instalment has been added to the long series of meteorological observations taken at the Radcliffe Observatory, Oxford, by the publication of a volume containing the results for the five years 1906–1910. In its main features the volume is arranged on the same lines as before, the principal exceptions being the omission of (1) the readings of the underground platinum-resistance thermometers, which will be dealt with in a separate paper, and (2) the results obtained from the photographic recording instruments, but the records are continued at present. The tables exhibit very clearly the mean daily, monthly, and annual results for the various elements. The wind velocity is deduced with the old factor 3, but to reduce this to the new factor 2·2 it is only necessary to multiply the quantities by 0·733. From a special table prepared by Dr. Rambaut for the thirty years 1881–1910, the mean yearly horizontal motion of the air is 108,000 miles; it shows an apparent periodic annual variation, with an amplitude of about 3·8 miles an hour, the maximum occurring in March and the minimum in September.

The report recently issued by the Survey Department of Egypt upon the rains of the Nile basin and the flood of 1910 claims that the decade which has just passed ranks as the most important in the study of the Nile from the hydrographical and meteorological points of view. The investigations during that period are chiefly due to the instigation and personal efforts of Sir W. Garstin and to the discussion of his data by various men of science. Among the principal results of this work are:—(1) A proper appreciation of the enormous loss of water in marshy regions. (2) The regulating effect of the trough wherever a rapid tributary joins a more sluggish one. (3) A more precise knowledge of the relative parts played by the different tributaries. (4) The importance of the contribution returned to the river from underground sources. During 1910 there was a general or partial failure of rain in the first half of the year, but during the critical months, July to September, there was heavy rain in Abyssinia and round the Bahr el Jebel, and this condition persisted into the last quarter. The low stage preceding the flood was very satisfactory and water was plentiful. The flood started well in April, but was subject subsequently to several fluctuations; from November 1 the fall was rapid, but the river remained above its normal level.

In our "Notes" column of April 25 we made a brief reference to a report on the climate of Tripoli by Dr. Philip Eredia, based on direct observations between 1892 and 1911. He has now supplemented that useful paper by one on the diurnal range of temperature, based on readings of a self-recording thermometer since September, 1905 (*Rendiconti R. Accad. Lincei*, July, 1912). The tables contain, *inter alia*, ten-day and monthly means for every even hour (2h., 4h., &c.). These show that the highest mean values occur about 2h. p.m., and differ little from those at other hours near that time, except in the decades of the extreme months; the lowest readings generally occur near sunrise, as is usually the case. The mean daily extremes occur early in February (11·4° C.) and about the middle of August (26·5°), giving a mean range of 15° C., which differs little from that of the coastal towns of southern Italy. The peculiarities exhibited by the hourly means in the various months are well shown by thermo-isopleths.

We have received Nos. 7–9 of the *Finländische hydrographisch-biologische Untersuchungen* in the gulfs of Bothnia and Finland and the northern part of the Baltic Sea during the years 1900–1910. These very valuable observations and results, including sea-temperature at various depths, salinity, wind direction and force, and other data at lightships, lighthouses, and other fixed stations, as well as during expeditions to sea, have been discussed by Dr. Rolf Witting, director of the investigations, and translated into German by Mrs. Ellen Witting. The principal results are also shown graphically by a number of coloured plates. We note that the author is of opinion that more importance should be given to detailed observations at fixed stations in supplementing the observations made in the open sea than has hitherto been the case. The discussion covers too wide a range to allow of our entering into further details here, but we may mention that one of the chapters contains an interesting historical account of the development of our knowledge of the hydrography of the Baltic prior to the commencement of the international exploration of the ocean.

THE BRITISH ASSOCIATION AT DUNDEE.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY LEONARD HILL, M.B., F.R.S., PRESIDENT OF THE SECTION.

LAST year the distinguished president of this section raised us to the contemplation of the workings of the soul. I ask you to accompany me in the consideration of nothing higher than a stuffy room. Everyone thinks that he suffers in an ill-ventilated room owing to some change in the chemical quality of the air, be it want of oxygen, or excess of carbon dioxide, the addition of some exhaled organic poison, or the destruction of some subtle property by passage of the air over steam-coils, or other heating or conducting apparatus. We hear of "devitalised" or "dead" air, and of "tinned" or "potted" air of the battleship. The good effects of open-air treatment, sea and mountain air, are no less generally ascribed to the chemical purity of the air. In reality the health-giving properties are those of temperature, light, movement, and relative moisture of the surrounding atmosphere, and leaving on one side those gross chemical impurities which arise in mines and in some manufacturing processes, and the question of bacterial infection, the alterations in chemical composition of the air in buildings where people crowd together and suffer from the effects of ill-ventilation have nothing to do with the causation of these effects.

Satisfied with the maintenance of a specious standard of chemical purity, the public has acquiesced in the elevation of sky-scrapers and the sinking of cavernous places of business. Many have thus become cave-dwellers, confined for most of their waking and sleeping hours in windless places, artificially lit, monotonously warmed. The sun is cut off by the shadow of tall buildings and by smoke—the sun, the energiser of the world, the giver of all things which bring joy to the heart of man, the fitting object of worship of our forefathers.

The ventilating and heating engineer hitherto has followed a great illusion in thinking that the main objects to be attained in our dwellings and places of business are chemical purity of the air and a uniform draughtless summer temperature.

Life is the reaction of the living substance to the ceaseless play of the environment. Biotic energy arises from the transformation of those other forms of energy—heat, light, sound, &c.—which beat upon the transformer—the living substance (B. Moore). Thus, when all the avenues of sense are closed, the central nervous system is no longer aroused and consciousness lapses. The boy paralysed in almost all his avenues of sense fell asleep whenever his remaining eye was closed. The patient who lost one labyrinth by disease, and, to escape unendurable vertigo, had the other removed by operation, was quite unable to guide his movements or realise his position in the dark. Rising from bed one night, he collapsed on the floor and remained there helpless until succour arrived.

A sense organ is not stimulated unless there is a change of rate in the transference of energy; and this to be effectual must occur in most cases with considerable quickness. If a weak agent is to stimulate, its application must be abrupt (Sherrington). Thus the slow changes of barometric pressure on the body-surface originate no skin sensations, though such changes of pressure if applied suddenly, are much above the threshold value for touch. A touch excited by constant mechanical pressure of slight intensity fades quickly below the threshold of sensation. Thus the almost unbearable discomfort which a child feels on putting on for the first time a "natural" wool vest fades away, and is no longer noticed with continual wear. Thomas à Beckett soon must have become oblivious to his hair-shirt, and even to its harbingers. It is not the wind which God tempers to the shorn lamb, but the skin of the lamb to the wind. The inflow of sensations keeps us active and alive and all the organs working in their appointed functions. The cutaneous sensations are of the highest importance. The salt and sand of wind-driven sea air particularly act on the skin and through it brace the whole body. The changing play of wind, of light, cold, and warmth stimulate the activity and health of mind and body. Monotony of sedentary occupation and of an over-warm still atmosphere endured for long working hours destroys vigour and happiness and brings about the atrophy of disuse. We hear a great deal of the degeneration of the race brought about by city life, but observation shows us that a drayman, navvy, or policeman can live in London, or other big city, strong and vigorous, and no less so than in the country. The brain-worker, too, can keep himself perfectly fit if his hours of sedentary employment are not too long and he balances these by open-air exercise. The horses stabled, worked, and fed in London are as fine as any in the world; they do not live in windless rooms heated by radiators.

The hardy men of the north were evolved to stand the vagaries of climate—cold and warmth—a starved or full belly have been their changing lot. The full belly and the warm sun have expanded them in lazy comfort; the cold and the starvation have braced them to action. Modern civilisation has withdrawn many of us from the struggle with the rigours of nature: we seek for and mostly obtain the comfort of a full belly and expand all the time in the warm atmosphere afforded us by clothes, wind-protected dwellings, and artificial heat—particularly so in the winter, when the health of the business man deteriorates. Cold is not comfortable, neither is hunger; therefore we are led to ascribe many of our ills to exposure to cold, and seek to make ourselves strong by what is termed good living. I maintain that the bracing effect of cold is of supreme importance to health and happiness, that we become soft and flabby and less resistant to the attacks of infecting bacteria in the winter, not because of the cold, but because of our excessive precautions to preserve ourselves from cold; that the prime cause of "cold" or "chill" is not really exposure to cold, but to the overheated and confined air of rooms, factories, and meeting-places. Seven hundred and eleven survivors were saved from the *Titanic* after hours of exposure to cold. Many were insufficiently clad and others wet to the skin. Only one died after reaching the *Carpathia*, and he three hours after being picked up. Those who died perished from actual cooling of the body. Exposure to cold did not cause in the survivors the diseases commonly attributed to cold.

Conditions of city and factory life diminish the physical and nervous energy, and reduce many from the vigorous health and perfectness of bodily functions which a wild animal possesses to a more secure, but poorer and far less happy, form of existence. The ill-chosen diet, the monotony and sedentary nature of daily work, the windless uniformity of atmosphere, above all, the neglect of vigorous muscular exercise in the open air and exposure to the winds and light of heaven—all these, together with the difficulties in the way of living a normal sexual life, go to make the pale, undeveloped, neurotic, and joyless citizen. Nurture in unnatural surroundings, not nature's birth-mark, moulds the criminal and the wastrel. The environment of childhood and youth is at fault rather than the stock; the children who are taken away and trained to be sailors, those sent to agricultural pursuits in the Colonies, those who become soldiers, may develop a physique and bodily health and vigour in striking contrast to their brothers who become clerks, shop assistants, and compositors.

Too much stress cannot be put on the importance of muscular exercise in regard to health, beauty, and happiness. Each muscle fills with blood as it relaxes, and expels this blood on past the venous valves during contraction. Each muscle, together with the venous valves, forms a pump to the circulatory system. It is the function of the heart to deliver the blood to the capillaries, and the function of the muscles—visceral, respiratory, and skeletal—to bring it back to the heart. The circulation is contrived for a restless mobile animal; every vessel is arranged so that muscular movement furthers the flow of blood.

The pressure of the blood in the veins and arteries under the influence of gravity varies with every change of posture. The respiratory pump, too, has a profound influence on the circulation. Active exercise, such as is taken in a game of football, entails endless changes of posture, varying compressive actions—one with another struggling in the rough and tumble of the game—forcible contractions and relaxations of the muscles, and a vastly increased pulmonary ventilation; at the same time the heart's action is accelerated and augmented and the arterial supply controlled by the vasomotor system. The influence of gravity, which tends to cause the fluids of the body to sink into the lower parts, is counteracted; the liver is rhythmically squeezed like a sponge by the powerful respiratory movements, which not only pump the blood through the abdominal viscera but thoroughly massage these organs, and kneading these with the omentum clean the peritoneal cavity and prevent constipation. At the same time the surplus food metabolic products, such as sugar and fat, stored in the liver, are consumed in the production of energy, and the organs swept with a rapid stream of blood containing other products of muscular metabolism which are necessary to the interrelation of chemical action. The output of energy is increased very greatly; a resting man may expend two thousand calories per diem; one bicycling hard for most of the day expended eight thousand calories, of which only four thousand was covered by the food eaten.

Such figures show how fat is taken off from the body by exercise, for the other four thousand calories comes from the consumption of surplus food products stored in the tissues. While resting a man breathes some 7 litres of air, and uses 300 c.c. of oxygen per minute, against 140 litres and 3000 c.c. while doing very hard labour. The call of the muscles for oxygen through such waste products as lactic acid impels the formation of red corpuscles and hæmoglobin. The products of muscular metabolism in other ways not yet fully defined modify the metabolism of the whole body.

Exposure to cold, cold baths, and cold winds has a like effect, accelerating the heart and increasing the heat production, the activity of the muscles, the output of energy, the pulmonary ventilation, and intake of oxygen and food. In contrast with the soft pot-bellied, over-fed city man the hard, wiry fisherman trained to endurance has no superfluity of fat or tissue fluid. His blood volume has a high relative value in proportion to the mass of his body. His superficial veins are confined between a taut skin and muscles, hard as in a racehorse trained to perfection. Thus the adequacy of the cutaneous circulation and loss of heat by radiation rather than by sweating is assured. His fat is of a higher melting point, hardened by exposure to cold. In him less blood is derived to other parts, such as adipose tissue, skin, and viscera. He uses up the oxygen in the arterial blood more completely and with greater efficiency; for the output of each unit of energy his heart has to circulate much less blood (Kreogh); his blood is sent in full volume by the well-balanced activity of his vasomotor system to the moving parts. Owing to the perfect coordination of his muscles, trained to the work, and the efficient action of his skin and cutaneous circulation—the radiator of the body—he performs the work with far greater economy and less fatigue. The untrained man may obtain 12 per cent. of his energy output as work, against 30 per cent., or perhaps even 50 per cent., obtained by the trained athlete. Hence the failure and risk suffered by the city man who rushes straight from his office to climb the Alps. On the other hand, the energetic man of business or brain worker is kept by his work in a state of nervous tension. He considers alternative lines of action, but scarcely moves. He may be intensely excited, but the natural muscular response does not follow. His heart is accelerated and his blood pressure raised, but neither muscular movements and accompanying changes of posture, nor the respiratory pump materially aid the circulation. The activity of his brain demands a rapid flow of blood, and his heart has to do the circulatory work, as he sits still or stands at his desk, against the influence of gravity. Hence a high blood pressure is maintained for long periods at a time by vaso-constriction of the arteries in the lower parts of the body and increased action of the heart; hence, perhaps, arise those degenerative changes in the circulatory system which affect some men tireless in their mental activity. We know that the bench-worker, who stands on one leg for long hours a day, may suffer from degeneration and varicosity of the veins in that leg. Long-continued high arterial pressure, with systolic and diastolic pressures approximately the same, entails a stretched arterial wall, and this must impede the circulation in the vaso-vasorum, the flow of tissue lymph in, and nutrition of, the wall. Since his sedentary occupation reduces the metabolism and heat production of his body very greatly, the business man requires a warmer atmosphere to work in. If the atmosphere is too warm it reduces his metabolism and pulmonary ventilation still further; thus he works in a vicious circle. Exhausting work causes the consumption of certain active principles, for example, adrenin, and the reparation of those must be from the food. To acquire certain of the rarer principles expended in the manifestation of nervous energy more food may have to be eaten by the sedentary worker than can be digested and metabolised. His digestive organs lack the kneading and massage, the rapid circulation and oxidation of foodstuffs which is given by muscular exercise. Hence arise the digestive and metabolic ailments so common to brain workers.

Mr. Robert Milne informs me that of the thousands of children who have passed through Barnardo's Homes—there are 9000 in the homes at any one time—not one after entering the institution and passing under its regimen and the care of his father, Dr. Milne, has developed appendicitis. Daily exercise and play, adequate rest, a regular, simple diet have ensured their immunity from this infection. It pays to keep a horse healthy and efficient; it no less pays to keep men healthy. I recently investigated the case of clerks employed in a great place of business, whose working hours are from 9 to 6 on three days, and 7 to 9 on the other three days of each week, and working such overtime, they make 1*l.* to 2*l.* a week; these clerks worked in a confined space—forty or fifty of them in 8200 cubic feet, lit with thirty electric lamps, cramped for room, and overheated in warm summer days. It is not with the chemical purity of the air of such an office that fault is to be found, for fans and large openings ensured this sufficiently. These clerks suffered from their long hours of monotonous and sedentary occupation, and from the artificial light, and the windless, overwarm and moist atmosphere. Many a girl cashier has worked from 8 to 8.30, and on Saturdays from 8 to 10, and then has had to balance her books and leave perhaps after midnight on Sunday morning. Her office is away in the background—confined, windless, artificially lit. The Shops Act has given a little relief from these hours. What, I ask, is the use of the State spending a million a year on sanatoria and tuberculin dispensaries, when those very conditions of work continue which lesson the immunity and increase the infection of the workers?

The jute industry in this town of Dundee is carried out almost wholly by female and boy labour. "The average wages for women are below 12*s.* in eight processes, and above 12*s.*, but under 18*s.*, for the remaining five processes." The infant mortality has been more than 170 per 1000. The Social Union of Dundee reported in 1905 that of 885 children born to 240 working mothers no fewer than 520, or 59 per cent., died—and almost all of them were under five years of age. The life of these mothers was divided between the jute factory and the one-roomed tenement. Looking such conditions squarely in the face, I say it would be more humane for the State to legalise the exposure of every other new-born infant on the hillside rather than allow children to be slowly done to death. The conditions, as given in the report, contravene those rights of motherhood which the meanest wild animal can claim.

Isolation hospitals, sputum-pots, and anti-spitting regulations will not stamp out tuberculosis. Such means are like shutting the door of the stable when the horse has escaped. Flügge has shown that tubercle bacilli are spread by the droplets of saliva which are carried out as an invisible spray when we speak, sing, cough, sneeze. Sputum-pots cannot control this. The saliva of cases of phthisis may teem with the bacilli. The tuberculin reaction tests carried out by Hamburger and Monti in Vienna show that 94 per cent. of all children aged eleven to fourteen have been infected with tubercle. In most the infection is a mere temporary indisposition. I believe that the conditions of exhausting work, and amusement in confined and overheated atmospheres, together with ill-regulated feeding, determine largely whether the infection, which almost none can escape, become serious or not. Karl Pearson suggests that the death statistics afford no proof of the utility of sanatoria or tuberculin dispensaries, for during the very years in which such treatment has been in vogue, the fall in the mortality from tuberculosis has become less relatively to the fall in general mortality. He opines that the race is gradually becoming immune to tubercle, and hence the declination in the mortality curve is becoming flattened out—that nature is paramount as the determinant of tuberculosis, not nurture. From a statistical inquiry into the incidence of tuberculosis in husband and wife and parent and child, Pearson concludes that exposure to infection as in married couples is of little importance, while inborn immunity or diathesis is a chief determinant. Admitting the value of his critical inquiries and the importance of diathesis, I would point out that in the last few years the rush and excitement of modern city life has increased, together with the confinement of workers to sedentary occupations in artificially lit, warm, windless atmospheres. The same conditions pertain to places of amusement, eating-houses, tube railways, &c.

Central heating, gas-radiators, and other contrivances are now displacing the old open fire and chimney. This change greatly improves the economical consumption of coal and the light and cleanliness of the atmosphere. But in so far as it promotes monotonous, windless, warm atmospheres, it is wholly against the health and vigour of the nation. The open fire and wide chimney ensure ventilation, the indrawing of cold outside air, streaky air—restless currents at different temperatures, which strike the sensory nerves in the skin and prevent monotony and weariness of spirit. By the old open fires we were heated with radiant heat. The air in the rooms was drawn in cool and varied in temperature. The radiator and hot-air system give us a deadly uniformly heated air—the very conditions we find most unsupportable on a close summer's day.

In Labrador and Newfoundland, Dr. Wakefield tells me, the mortality of the fisherfolk from tuberculosis is very heavy. It is generally acknowledged to be four per 1000 of the population per annum, against 1·52 for England and Wales. Some of the Labrador doctors talk of seven and even eight per 1000 in certain districts. The general death-rate is a low one. The fishermen fish off shore, work for many hours a day in the fishing season, and live with their families on shore in one-roomed shanties. These shanties are built of wood, the crannies are "stogged" with moss, and the windows nailed up, so that ventilation is very imperfect. They are heated by stoves and kept at a very high temperature, *e.g.*, 80° F. Outside in the winter the temperature may be 30 degrees below freezing. The women stay inside the shanties almost all their time, and the tuberculosis rate is somewhat higher in them. The main food is white bread, tea stewed in the pot till black, fish occasionally, a little margarine and molasses. The fish is boiled and the water thrown away. Game has become scarce in recent years; old, dark-coloured flour spoken of with disfavour—has been replaced by white flour. In consequence of this diet beri-beri has become rife to a most serious extent, and the hospitals are full of cases. Martin Flack and I have found by our feeding experiments that rats, mice, and pigeons cannot be maintained on white bread and water, but can live on wholemeal, or on white bread in which we incorporate an extract of the sharps and bran in sufficient amount. Recent work has shown the vital importance of certain active principles present in the outer layers of wheat, rice, &c., and in milk, meat, &c., which are destroyed by heating to 120° C. A diet of white bread or polished rice and tinned food sterilised by heat is the cause of beri-beri. The metabolism is endangered by the artificial methods of treating foods now in vogue. As to the prevalency of tuberculosis in Labrador, we have to consider the intermarriage, the bad diet, the over-rigorous work of the fishermen, the overheating of, and infection in, the shanties. Dr. Wakefield has slept with four other travellers in a shanty with father, mother, and ten children. In some there is scarce room on the floor to lie down. The shanties are heated with a stove on which pots boil all the time; water runs down the windows. The patients are ignorant, and spit everywhere, on bed, floor, and walls. In the schools the heat and smell are most marked to one coming in from the outside air. In one school 50 cubic feet per child is the allowance of space. The children are eating all day long, and are kept in close hot confinement. They suffer very badly from decay of the teeth. Whole families are swept off with tuberculosis, and the child who leaves home early may escape, while the rest of a family dies.

Here, then, we have people living in the wildest and least populated of lands with the purest atmosphere suffering from all those ill-results which are found in the worst city slums—tuberculosis, beri-beri, and decayed teeth.

The bad diet probably impels the people to conserve their body heat and live in the over-warm, confined atmosphere, just as our pigeons fed on white bread sit, with their feathers out, huddled together to keep each other warm. The metabolism, circulation, respiration, and expansion of the lung are all reduced. The warm, moist atmosphere lessens the evaporation from the respiratory tract, and therefore the transudation of tissue lymph and activity of the ciliated epithelium. The unexpanded parts of the lung are not swept with blood. Everything favours a lodgment of the bacilli, and lessens the defences on which immunity depends. In the mouth, too, the immune properties of the saliva are neutralised by the continual presence of food, and the temperature of the mouth is kept at a high level, which favours bacterial growth. Lieutenant Siem informs me that recently in Northern Norway there has been the same notable increase in tuberculosis. The old cottage fireplaces with wide chimneys have been replaced with American stoves. In olden days most of the heat went up the chimney, and the people were warmed by radiant heat. Now the room is heated to a uniform moist heat. The Norwegians nail up the windows and never open them during the winter. At Lofoten, the great fishing centre, motor-boats have replaced the old open sailing and row boats. The cabin in the motor-boat is very confined, covered in with watertight deck, heated by the engine, crowded with six or eight workers. When in harbour the fishermen used to occupy ill-fitted shanties, through which the wind blew freely; now, to save rent, they sleep in the motor-boat cabins.

Here, again, we have massive infection, and the reduction of the defensive mechanisms by the influence of the warm, moist atmosphere.

The Norwegian fishermen feed on brown bread, boiled fish, salt mutton, margarine, and drink, when in money, beer and schnapps; there is no gross deficiency in diet, as in Labrador, and beri-beri does not attack them. They return home to their villages and longshore fishing when the season is over. The one new condition which is common to the two districts is confinement in stove-heated, windless atmospheres. In old days the men were crowded together, but in open boats or in draughty shanties, and had nothing but little cooking-stoves.

The conditions of great cities tend to confine the worker in the office all way, and to the heated atmosphere of club, cinema show, or music hall in the evening. The height of houses prevents the town dweller from being blown upon by the wind, and, missing the exhilarating stimulus of the cool, moving air, he repels the dull uniformity of existence by tobacco and by alcohol, or by indulgence in food, *e.g.*, sweets, which are everywhere to his hand, and by the nervous excitement of business and amusement. He works, he eats, and is amused in warm, windless atmospheres, and suffers from a feeble circulation, a shallow respiration, a disordered digestion, and a slow rate of metabolism.

Many of the employments of modern days are detestable in their long hours of confinement and monotony. Men go up and down in a lift all day, and girls in the bloom of youth are set down in tobacco stalls in underground stations, and their health and beauty there fade while even the blow-flies are free to bask in the sun. In factories the operatives feed machines, or reproduce the same small piece of an article day after day. There is no art, or change; no pleasure in contrivance and accomplishment. The miner, the fisherman, even the sewer-man, face difficulties, changing risks, and are developed as men of character and strength. Contrast the sailor with the steward on a steamer, the drayman outside with the clerk inside who checks the goods delivered at some city office, the butcher and the tailor, the seamstress and the market woman, and one sees the enormous difference which a confined occupation makes. Monotonous sedentary employment makes for unhappiness because the inherited functional needs of the human body are neglected, and education—when the outside field of interest is narrowed intensifies the sensitivity to the bodily conditions. The sensations arising within the body—proprioceptive sensations—come to have too large a share in consciousness in comparison with exteroceptive. In place of considering the lilies how they grow, or musing on the beauty and motions of the heavenly bodies, the sedentary worker in the smoke-befouled atmosphere, with the limited activity and horizon of an office and a disturbed digestion, tends to become confined to the inward consideration of his own viscera and their motions.

Many of the educated daughters of the well-to-do are no less confined at home; they are the flotsam and jetsam cast up from the tide in which all others struggle for existence—their lives are no less monotonous than the sweated sempstress or clerk. They become filled with "vapours" and some seek excitement not at the cannon's mouth but in breaking windows, playing with fire, and hunger strikes. The dull monotony of idle social functions, shopping and amusement no less than that of sedentary work and an asexual life, impels to a simulated struggle—a theatrical performance, the parts of which are studied from the historical romances of revolution. Each man, woman, and child in the world must find the wherewithal for living, food, raiment, warmth, and housing, or must die or get some other to find it for him. It seems to me as if the world is conducted as if ten men were on an island—a microcosm—and five sought for the necessaries of life, hunted for food, built shelters and fires, made clothes of skins, while the other five strung necklaces of shells, made loin-cloths of butterfly wings, gambled with knuckle-bones, drew comic pictures in the sand, or carved out of clay frightening demons, and so beguiled from the first five the larger share of their wealth. In this land of factories, while the many are confined to mean streets and wretched houses, possessing no sufficiency of baths and clean clothing, and are ill-fed, they work all day long, not to fashion for themselves better houses and clothing, but to make those unnecessaries such as "the fluff" of women's apparel, and a thousand trifles which relieve the monotony of the idle and bemuse their own minds.

The discovery of radium and its disintegration as a source of energy has enabled the physicist to extend Lord Kelvin's estimate of the world's age from some thirty to a thousand million years. Arthur Keith does not hesitate to give a million of these years to man's evolution. Karl Pearson speaks of hundreds of thousands of years. The form of the human skull, the brain capacity of man, his skill as evidenced by stone implements and cave drawings of animals in action, was the same tens of thousands of years ago as now. For ages primitive man lived as a wild animal in tropical climes, discovered how to make fire, clothe himself in skins, build shelters, and so enable himself to wander over the temperate and arctic zones. Finally, in the last few score of years, he has made houses draughtless with glass windows, fitted them with stoves and radiators, and every kind of device to protect himself from cold, while he occupies himself in the sedentary pursuits and amusements of a city life. How much better, to those who know the boundless horizon of life, to be a frontiersman and enjoy the struggle, with body hardened, perfectly fit, attuned to nature, than to be a cashier condemned to the occupation of a sunless, windless pay-box. The city child, however, nurtured and educated in confinement, knows not the largeness and wonders of Nature, is used to the streets with their ceaseless movement and romantic play of artificial light after dark, and does not need the commiseration of the country mouse any more than the beetle who lives in the dark and animated burrows of his heap. But while outdoor work disciplines the body of the countryman into health, the town man needs the conscious attention and acquired educated control of his life to give him any full measure of health and happiness.

Experimental evidence is strongly in favour of my argument that the chemical purity of the air is of no importance. Analyses show that the oxygen in the worst-ventilated school-room, chapel, or theatre is never lessened by more than 1 per cent. of an atmosphere; the ventilation through chink and cranny, chimney, door, and window, and the porous brick wall, suffices to prevent a greater diminution. So long as there is present a partial pressure of oxygen sufficient to change the hæmoglobin of the venous blood into oxyhæmoglobin there can arise no lack of oxygen.

At sea-level the pressure of oxygen in the pulmonary alveolar air is about 100 mm. Hg. Exposed to only half this pressure the hæmoglobin is more than 80 per cent. saturated with oxygen.

In noted health-resorts of the Swiss mountains the barometer stands at such a height that the concentration of oxygen is far less than in the more ventilated room. On the high plateau of the Andes there are great cities: Potosi with a hundred thousand inhabitants is at 4,105 metres, and the partial pressure of oxygen there is about 13 per cent. of an atmosphere in place of 71 per cent. at sea-level; railways and mines have been worked up to altitudes of 14,000 to 15,000 feet. At Potosi girls dance half the night, and toreadors display their skill in the ring. On the slopes of the Himalayas shepherds take their flocks to altitudes of 18,000 feet. No disturbance is felt by the inhabitants or those who reach these great altitudes slowly and by easy stages. The only disability to a normal man is diminished power for severe exertion, but a greater risk arises from want of oxygen to cases of heart disease, pneumonia, and in chloroform anæsthesia at these high altitudes. The newcomer who is carried by the railway in a few hours to the top of Pike's Peak or the Andes may suffer severely from mountain sickness, especially on exertion, and the cause of this is want of oxygen. Acclimatisation is brought about in a few days' time. The pulmonary ventilation increases, the bronchial tubes dilate, the circulation becomes more rapid. The increased pulmonary ventilation lowers the partial pressure of carbon dioxide in the blood and pulmonary air, and this contributes to the maintenance of an adequate partial pressure of oxygen. Haldane and Douglas say that the percentage of red corpuscles and total quantity of the hæmoglobin increases, and maintain that the oxygen is actively secreted by the lung into the blood, but the CO method by which their determinations have been made has not met with unqualified acceptance. If waste products, which arise from oxygen want, alter the combining power of hæmoglobin, this alteration may not persist in shed blood; for these products may disappear when the blood is exposed to air. Owing to the combining power of hæmoglobin the respiratory exchange and metabolism of an animal within wide limits are independent of the partial pressure of oxygen. On the other hand, the process of combustion is dependent not on the pressure, but on the percentage of oxygen. Thus the aeroplanist may become seized with altitude sickness from oxygen want, while his gas engine continues to carry him to loftier heights.

The partial pressure of oxygen in a mine at a depth of 3000 feet is considerably higher than at sea-level, and if the percentage is reduced to 17, while the firing of fire-damp and coal-dust is impossible, there need be in the alveolar air of the lungs no lower pressure of oxygen than at sea-level. Thus the simplest method of preventing explosions in coal mines is that proposed by J. Harger, viz., to ventilate them with air containing 17 per cent. of oxygen.[1] There is little doubt that all the great mine-explosions have been caused by the enforcement of a high degree of chemical purity of the air. In the old days when ventilation was bad there were no great dust explosions. Mr. W. H. Chambers, general manager of the Cadeby mine, where the recent disastrous explosion occurred, with the authority of his great and long practical experience of fiery mines, told me that the spontaneous combustion of coal and the danger of explosion can be wholly met by adequate diminution in ventilation. The fires can be choked out while the miners can still breathe and work. The Coal Mines Regulation Act enforces that a place shall not be in a fit state for working or passing therein, if the air contains either less than 19 per cent. of oxygen, or more than $1\frac{1}{4}$ per cent. of carbon dioxide. A mine liable to spontaneous combustion of coal may be exempted from this regulation by order of the Secretary of State.

The regulations impel the provision of such a ventilation current that the percentage of oxygen is sufficient for the spread of dust explosions along the intake airways, with the disastrous results so frequently recorded. If the mine were ventilated with air containing 17 per cent. of oxygen in sufficient volume to keep the miners cool and fresh, not only would explosions be prevented, but the mines could be safely worked and illuminated with electricity, and miners' nystagmus prevented, for this is due to the dim light of the safety lamp. The problem possibly may be solved by purifying and cooling the return air, and mixing and circulating this with a sufficiency of fresh air.

Owing to the fact that the percentage of CO_2 is the usual test of ventilation and that only a very few parts per 10,000 in excess of fresh air are permitted by the English Factory Acts, it is generally supposed that CO_2 is a poison, and that any considerable excess has a deleterious effect on the human body. No supposition could be further from the truth.

The percentage of CO_2 in the worst ventilated room does not rise above 0·5 per cent., or at the outside 1 per cent. It is impossible that any excess of CO_2 should enter into our bodies when we breathe such air, for whatever the percentage of CO_2 in the atmosphere may be, that in the pulmonary air is kept constant at about 5 to 6 per cent. of an atmosphere—by the action of the respiratory centre. It is the concentration of CO_2 which rules the respiratory centre, and to such purpose as to keep the concentration both in the lungs and in the blood uniform (Haldane); the only result from breathing air containing 0·5 to 1 per cent. of CO_2 is an inappreciable increase in the ventilation of the lungs. The very same thing happens when we take gentle exercise and produce more CO_2 in our bodies.

At each breath we rebreathe into our lungs the air in the nose and large air-tubes (the dead-space air), and about one-third of the air which is breathed in by a man at rest in dead-space air. Thus, no man breathes in pure outside air into his lungs. When a child goes to sleep with its head partly buried under the bedclothes, and in a cradle confined by curtains, he rebreathes the expired air to a still greater extent, and so with all animals that snuggle together for warmth's sake. Not only the new-born babe sleeping against its mother's breast, but pigs in a sty, young rabbits, rats, and mice clustered together in their nests, young chicks under the brooding hen, all alike breathe a far higher percentage than that allowed by the Factory Acts.

To rebreathe one's own breath is a natural and inevitable performance, and to breathe some of the air exhaled by another is the common lot of men who, like animals, have to crowd together and husband their heat in fighting the inclemency of the weather.

In the Albion Brewery we analysed on three different days the air of the room where the CO_2 generated in the vats is compressed and bottled as liquid carbonic acid. We found from 0·14 to 0·93 per cent. of CO_2 in the atmosphere of that room. The men who were filling the cylinders and turning the taps on and off to allow escape of air must often breathe more than this. The men engaged in this occupation worked twelve-hour shifts, having their meals in the room. Some had followed the same employment for eighteen years, and without detriment to their health. It is only when the higher concentrations of CO_2 are breathed, such as 3 to 4 per cent. of an atmosphere, that the respiration is increased, so that it is noticeable to the resting individual; but percentages over 1 per cent. diminish the power to do muscular work, for the excess of CO_2 produced by the work adds its effect to that of the excess in the air, and the difficulty of coordinating the breathing to the work in hand is increased.

Haldane and Priestley found that with a pressure of 2 per cent. of an atmosphere of CO_2 in the inspired air the pulmonary ventilation of a man at rest was increased 50 per cent., with 3 per cent. about 100 per cent., with 4 per cent. about 200 per cent., with 5 per cent. about 300 per cent., and with 6 per cent. about 500 per cent. With the last, panting is severe, while with 3 per cent. it is unnoticed until muscular work is done, when the panting is increased 100 per cent. more than usual. With more than 6 per cent. the distress is very great, and headache, flushing, and sweating occur.

Divers who work in diving dress and men who work in compressed-air caissons constantly do heavy and continuous labour in concentrations of CO_2 higher than 1 per cent. of an atmosphere, and so long as the CO_2 is kept below 2 to 3 per cent. they are capable of carrying out efficient work. In the case of workers in compressed air it is important to bear in mind that the effect of the CO_2 on the breathing depends on the partial pressure and not on the percentage of this gas in the air breathed.

By a series of observations made on rats confined

[1] Trans. Inst. of Mining Engineers, 1912.

in cages fitted with small, ill-ventilated sleeping-chambers, we have found that the temperature and humidity of the air—not the percentage of carbon dioxide or oxygen—determines whether the animals stay inside the sleeping-room or come outside. When the air is cold, they like to stay inside, even when the carbon dioxide rises to 4 to 5 per cent. of an atmosphere. When the sleeping-chamber is made too hot and moist they come outside.

The sanitarian says it is necessary to keep the CO_2 below 0·01 per cent., so that the organic poisons may not collect to a harmful extent. The evil smell of crowded rooms is accepted as unequivocal evidence of the existence of such. He pays much attention to this and little or none to the heat and moisture of the air. The smell arises from the secretions of the skin, soiled clothes, &c. The smell is only sensed by and excites disgust in one who comes to it from the outside air. He who is inside and helps to make the "fugg" is both wholly unaware of, and unaffected by it. Flügge points out, with justice, that while we naturally avoid any smell that excites disgust and puts us off our appetite, yet the offensive quality of the smell does not prove its poisonous nature. For the smell of the trade or food of one man may be horrible and loathsome to another not used to such.

The sight of a slaughterer and the smell of dead meat may be loathly to the sensitive poet, but the slaughterer is none the less healthy. The clang and jar of an engineer's workshop may be unendurable to a highly-strung artist or author, but the artificers miss the stoppage of the noisy clatter. The stench of glue-works, fried-fish shops, soap and bone-manure works, middens, sewers, become as nothing to those engaged in such, and the lives of the workers are in no wise shortened by the stench they endure. The nose ceases to respond to the uniformity of the impulse, and the stench clearly does not betoken in any of these cases the existence of a chemical organic poison. On descending into a sewer, after the first ten minutes the nose ceases to smell the stench; the air therein is usually found to be far freer from bacteria than the air in a schoolroom or tenement.

If we turn to foodstuffs we recognise that the smell of alcohol and of Stilton or Camembert cheese is horrible to a child, while the smell of putrid fish—the meal of the Siberian native—excites no less disgust in an epicure, who welcomes the cheese. Among the hardiest and healthiest of men are the North Sea fishermen, who sleep in the cabins of trawlers reeking with fish and oil, and for the sake of warmth shut themselves up until the lamp may go out from want of oxygen. The stench of such surroundings may effectually put the sensitive, untrained brain worker off his appetite, but the robust health of the fisherman proves that this effect is nervous in origin, and not due to a chemical organic poison in the air.

Ventilation cannot get rid of the source of a smell, while it may easily distribute the evil smell through a house. As Pettenkofer says, if there is a dung-heap in a room, it must be removed. It is no good trying to blow away the smell.

Flügge and his school bring convincing evidence to show that a stuffy atmosphere is stuffy owing to heat stagnation, and that the smell has nothing to do with the origin of the discomfort felt by those who endure it. The inhabitants of reeking hovels in the country do not suffer from chronic ill-health, unless want of nourishment, open-air exercise, or sleep come into play. Town workers who take no exercise in the fresh air are pale, anæmic, listless. Sheltered by houses they are far less exposed to winds, and live day and night in a warm, confined atmosphere.

The widespread belief in the presence of organic poisons in the expired air is mainly based on the statements of Brown Sequard and D'Arsenval, statements wholly unsubstantiated by the most trustworthy workers in Europe and America. These statements have done very great mischief to the cause of hygiene, for they led ventilating engineers and the public to seek after chemical purity, and neglect the attainment of adequate coolness and movement of the air. It was stated that the condensation water obtained from expired air is poisonous when injected into animals. The evidence on which this statement is based is not only not worthy of credence but is absurd, *e.g.* condensation water has been injected into a mouse in a quantity equivalent to injecting 5 kilogrammes into a man weighing 60 kilogrammes. No proper controls were carried out. It is recognised now that any distilled water contaminated by bacterial products may have a toxic effect. Flack and I have for fourteen weeks kept guinea-pigs and rats confined together in a box and poorly ventilated, so that they breathed air containing 0·5 to 1·0 per cent. of CO_2. The guinea-pigs proved wholly free from anaphylactic shock on injecting rats' serum. Therefore they were not sensitised by breathing the exhaled breath of the rats for many weeks, and we are certain that no foreign protein substance is absorbed in this way. It has been proved by others, and by us, that animals so confined do well so long as they are well fed and their cages kept clean, light, cool, and dry. It is wholly untrue that they are poisoned by breathing each other's breath. The only danger arises from droplet contagion in cases of infective disease.

To study the relative effect of the temperature and chemical purity of the atmosphere, I constructed a small experimental chamber of wood fitted with large glass observation windows and rendered airtight.

On one side of the chamber were fixed two small electric heaters, and a tin containing water was placed on these in order to saturate the air with water vapour. On another side of the chamber was placed a large radiator through which cold water could be circulated when required, so as to cool the chamber. In the roof were fixed three electric fans, one big and two small, by means of which the air of the chamber could be stirred. The chamber held approximately 3 cm. of air. In one class of experiments we shut within the chamber seven or eight students for about half an hour, and observed the effect of the confined atmosphere upon them. We kept them until the CO_2 reached 3 to 4 per cent., and the oxygen had fallen to 17 to 16 per cent. The wet-bulb temperature rose meanwhile to about 80° to 85° F., and the dry-bulb a degree or two higher. The students went in chatting and laughing, but by and by, as the temperature rose, they ceased to talk and their faces became flushed and moist. To relieve the monotony of the experiment we have watched them trying to light a cigarette, and, puzzled by their matches going out, borrowing others, only in vain. They had not sensed the diminution of oxygen, which fell below 17 per cent. Their breathing was deepened by the high percentage of CO_2, but no headache occurred in any of them from the short exposure. Their discomfort was relieved to an astonishing extent by putting on the electric fans placed in the roof. Whilst the air was kept stirred the students were not affected by the oppressive atmosphere. They begged for the fans to be put on when they were cut off. The same old stale air containing 3 to 4 per cent. CO_2 and 16 to 17 per cent. O_2 was whirled, but the movement of the air gave relief, because the air was 80° to 85° F. (wet bulb), while the air enmeshed in their clothes in contact with their skin was 98° to 99° F. (wet bulb). If we outside breathed through a tube the air in the chamber we felt none of the discomfort which was being experienced by those shut up inside. Similarly, if one of those in the chamber breathed through a tube the pure air outside he was not relieved.

R. A. Rowlands and H. B. Walker carried out a large number of observations in the chamber, each acting as subject in turn.

They recorded the effect on the respiratory ventilation and on the pulse rate, both when resting and when working. The work consisted in pulling a 20-kilo. weight about 1 metre high by means of a pulley and rope.

In some of the experiments the exhaled carbonic acid was absorbed, and in others carbonic acid was put into the chamber. The subjects inside could not tell when the gas was introduced, not even if the percentage were suddenly raised by 2. The introduction of this amount of the gas made no sensible difference to them, but increased their pulmonary ventilation.

In every one of the experiments they suffered from the heat, and the putting on of the fans gave great relief, and in particular diminished the pulse rate during and after the working periods. The relief became much greater when cold water was circulated through the radiator and the temperature of the chamber lowered 10° F.

The subjects wore only a vest, pants, and shoes in most of these experiments. When they wore their ordinary clothing the effect on the frequency of the pulse was more marked and the discomfort from heat and moisture much greater.

I have made observations on men dressed in the Fleuss rescue apparatus for use in mines, and exposed in a chamber to 120° F. dry bulb and 95° F. wet bulb. The skin temperature rises to the rectal temperature and the pulse is greatly accelerated—*e.g.* to 150—and there arises danger of heat stroke. The conditions are greatly relieved by interposing on the inspiratory tube of the apparatus a cooler filled with carbonic acid snow. The cool inspired air lowers the frequency of the heart and makes it possible for the men to do some work at 95° F. wet bulb, and to endure this temperature for two hours.

The observations made by Pembrey and Collis on the weaving-mill operatives at Darwen show that the skin of the face may be 4° to 13° F. higher in the mill when the wet bulb is 71° F. than at home when the wet-bulb temperature is about 55° F. The tendency of the warm, humid atmosphere of the mill is to establish a more uniform temperature of the body as a whole (surface and deep temperatures) and to throw a tax upon the power of accommodation as indicated by the rapid pulse and low blood-pressure.

The mill workers are wet with the steam blown into the sheds, their clothes and bodies are moist, and the long hours of exposure to such uncomfortable conditions are most deleterious to physical vigour and happiness. The operatives asked that they might be allowed to work without steam-injectors and with diminished ventilation, so that the mill rooms became saturated with moisture evaporated from the bodies of the operatives. The old regulations, while forbidding more than 6 parts in 10,000 CO_2, put no limit to the wet-bulb temperature, and this often became excessive on hot summer days. The operatives were quite right. Less ventilation and a lower wet bulb is far better than ample ventilation and a high wet bulb. The permissible limit of CO_2 has now been raised to 11 parts in 10,000, and the wet-bulb temperature is to be controlled within reasonable limits.

The efficiency of workers in mills, mines, tunnels, stoke-holes, &c., is vastly increased by the provision of a sufficient draught of cool and relatively dry air, so as to prevent overtaxing of the heat-regulating mechanism. Mr. F. Green informs me that by means of forced draught the stokehole of an Orient steamer is rendered the coolest place when the ship is in the tropics.

The electric fan has vastly improved the conditions of the worker in the tropics. I would suggest that each clerk should have a fan just as much as a lamp on his desk. It will pay the employer to supply fans.

In the modern battleship men are confined very largely to places artificially lit and ventilated by air driven in by fans through ventilating-shafts. The heat and moisture derived from the bodies of the men, from the engines, from cooking-ranges, &c., lead to a high degree of relative moisture, and thus all parts of the ironwork inside are coated with granulated cork to hold the condensed moisture and prevent dripping.

The air smells with the manifold smells of oil, cooking, human bodies, &c., and the fresh air driven in by fans through the metal conduits takes up the smell of these, and is spoken of by the officers with disparagement as "tinned" or "potted" air. This air is heated when required by being made to pass over radiators. Many of the officers' cabins and offices for clerks, typewriters, &c., in the centre of a battleship, have no portholes, and are only lit and ventilated by artificial means. The steel nature of the structure prevents the diffusion of air which takes place so freely through the brick walls of a house. The men in their sleeping quarters are very closely confined, and as the openings of the air-conduits are placed in the roof between the hammocks, the men next to such openings receive a cold draught and are likely to shut the openings. To sleep in a warm moist "fugg" would not much matter if the men were actively engaged for many hours of the day on deck and there exposed to the open air and the rigours of sea and weather. In the modern warship most of the crew work for many hours under deck, and some of the men may scarcely come on deck for weeks or even months. Considering the conditions which pertain, it seems to be of the utmost importance that all the men in a battleship should be inspected at short intervals by the medical officers so that cases of tuberculosis may be weeded out in their incipiency. The men of every rating should do deck drill for some part of every day. In the Norwegian navy every man, cooks and all, must do gymnastic drill on deck once a day. In the case of our navy, with voluntary service, the men should welcome this in their own interest.

In a destroyer visited by me twelve men occupied quarters containing about 1700 cubic feet of air. There was a stove with iron pipe for chimney, from which fumes of combustion must leak when in use, and a fan which would not work. When the men are shut down the moisture is such that boots, &c., go mouldy, and the water drips off the structure. The cooling effect of the sea-water washing over the steel shell of the boat is beneficial in keeping down the temperature in these confined and ill-ventilated quarters. On the manœuvring platform in the engine-room the wet-bulb temperature reaches a very high degree owing to the slight escape of steam round the turbines. Commander Domvile was kind enough to send me the wet and dry bulb temperatures taken there on a number of days. The wet bulb was found to be never below 80° F., sometimes reaching 95° and even 98° F. It is impossible for officers to work at these temperatures without straining the heat-regulating mechanism of the body and diminishing their health and working capacity. If such wet-bulb temperatures are unavoidable, means should be provided, such as fans, which would alleviate the discomfort and fatigue caused thereby. A supply of compressed air fitted with a nozzle might be arranged and used occasionally to douche the body with cool air. I have tried this plan and found it very effectual.

and can recommend the compressed-air bath as the substitute for a bracing cold wind.

The suitability of the clothing is of the greatest importance, not only to the comfort but to the efficiency of man as a working machine, *e.g.* power of soldiers to march. On a still day the body is confined by the clothes as if by a chamber of stagnant air, for the air is enclosed in the meshes of the clothes and the layer in contact with the skin becomes heated to body temperature and saturated with moisture.

The observations of Pembrey show that himself and four soldiers, marching in drill order on a moderately warm day, lost more water and retained more water in their clothes than on another similar day when they worked with no jacket on. The average figures were loss of moisture 1600, against 1200 grms., and water retained in clothes 254, against 109 grms. With no jacket the pulse was, on the average, increased 28 against 41 in drill order, and rectal temperature 1° against 1·5° F. The taking off of the jacket or throwing open of the jacket and vest very greatly increase the physiological economy of a march. It is absurd that on a hot summer day Boy Scouts should march with coloured scarves knotted round their necks. Nothing should be worn for ornament or smartness which increases the difficulty of keeping down the body temperature. The power to march and the efficiency of an army depend on prevention of heart stagnation and avoidance of fatigue of the heart.

I conclude, then, that all the efforts of the heating and ventilating engineer should be directed towards cooling the air in crowded places and cooling the bodies of the people by setting the air in motion by means of fans. In a crowded room the air confined between the bodies and clothes of the people is almost warmed up to body temperature and saturated with moisture, so that cooling of the body by radiation, convection and evaporation becomes reduced to a minimum. The strain on the heat-regulating mechanism tells on the heart. The pulse is accelerated, the blood is sent in increased volume to the skin, and circulates there in far greater volume, while less goes through the viscera and brain. As the surface temperature rises, the cutaneous vessels dilate, the veins become filled, the arteries may become small in volume, and the blood-pressure low, the heart is fatigued by the extra work thrown upon it. The influence of the heat stagnation is shown by the great acceleration of the pulse when work is done, and the slower rate at which the pulse returns to its former rate on resting.

The increased percentage of carbonic acid and diminution of oxygen which has been found to exist in badly ventilated churches, schools, theatres, barracks, is such that it can have no effect upon the incidence of respiratory disease and higher death-rate which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. The conditions of temperature, moisture, and windless atmosphere in such places primarily diminish the heat loss, and secondarily the heat production, *i.e.*, the activity of the occupants, together with total volume of air breathed, oxygen taken in and food eaten. The whole metabolism of the body is thus run at a lower plane, and the nervous system and tone of the body is unstimulated by the monotonous, warm, and motionless air. If hard work has to be done it is done under conditions of strain. The number of pathogenic organisms is increased in such places, and these two conditions run together—diminished immunity and increased mass influence of infecting bacteria.

The volume of blood passing through, and of water vapour evaporated from, the respiratory mucous membrane must have a great influence on the mechanisms which protect this tract from bacterial infection. While too wet an atmosphere lessens evaporation, a hot dry atmosphere dries up the mucous membrane. As the immunising powers depend on the passage of blood plasma into the tissue spaces, it is clear that a proper degree of moisture is important. The temperature, too, must have a great influence on the scavenger activity of the ciliated epithelium and leucocytes in the mucous membrane of the nose.

In the warm moist atmosphere of a crowded place the infection from spray, sneezed, coughed, or spoken out, is enormous. On passing out from such an atmosphere into cold moist air the respiratory mucous membrane of the nose is suddenly chilled, the blood-vessels constricted, and the defensive mechanism of cilia and leucocyte checked. Hence the prevalence of colds in the winter. In the summer the infection is far less. We are far more exposed to moving air, and the sudden transition from a warm to a cold atmosphere does not occur. I believe that infection is largely determined by (1) the mass influence of the infecting agent; (2) the shallow breathing and diminished evaporation from, and flow of tissue lymph through, the respiratory tract, in warm, moist confined air. Colds are not caught by exposure to cold *per se*, as is shown by the experience of Arctic explorers, sailors, shipwrecked passengers, &c.

We have very great inherent powers of withstanding exposure to cold. The bodily mechanisms become trained and set to maintain the body heat by habitual exposure to open-air life. The risk lies in overheating our dwellings and overclothing our bodies, so that the mechanisms engaged in resisting infection become enfeebled, and no longer able to meet the sudden transition from the warm atmosphere of our rooms to the chill outside air of winter. The dark and gloomy days of winter confine us within doors, and, by reducing our activity and exposure to open air, depress the metabolism; the influence of smoke and fog, gloom of house and streets, cave-like places of business and dark dwellings, intensify the depression. The immunity to a cold after an infection lasts but a short while, and when children return, after the summer holidays, to school and damp chill autumn days, infection runs around. The history of hospital gangrene and its abolition by the aseptic methods of Lister—likewise the history of insect-borne disease—show the great importance of cleanliness in crowded and much occupied rooms. The essentials required of any good system of ventilating are then (1) movement, coolness, proper degree of relative moisture of the air; (2) reduction of the mass influence of pathogenic bacteria. The chemical purity of the air is of very minor importance, and will be adequately insured by attendance to the essentials.

As the prevention of spray (saliva) infection by ventilation is impossible in crowded places, it behoves us to maintain our immunity at a high level. We may seek to diminish the spray output of those infected with colds by teaching them to cough, sneeze, and talk with a handkerchief held in front of the mouth, or to stay at home until the acute stage is past.

In all these matters nurture is of the greatest importance, as well as nature. A man is born with physical and mental capacities small or great, with inherited characteristics, with more or less immunity to certain diseases, with a tendency to longevity of life or the opposite, but his comfort and happiness in life, the small or full development of his physical and mental capacities, his immunity and his longevity of life, are undoubtedly determined to a vast extent by nurture.

By nurture—I use the word in its widest sense to include all the defensive methods of sanitary science—plague, yellow fever, malaria, sleeping-sickness, cholera, hospital gangrene, &c., can be prevented by eliminating the infecting cause; smallpox and typhoid by this means, and also by vaccination; and most of the other ills which flesh is supposed to be heir to can be kept from troubling by approximating to the rules of life which a wild animal has to follow in the matter of a simple, and often spare diet, hard exercise, and exposure to the open air.

There is nothing more fallacious than the supposition commonly held that over-feeding and over-coddling indoors promotes health. The two together derange the natural functions of the body. He who seeks to save his life will lose it.

The body of a new-born babe is a glorious and perfect machine, the heritage of millions of years of evolution.

> "Not in entire forgetfulness,
> And not in utter nakedness,
> But trailing clouds of glory do we come.
>
> . . . .
>
> Shades of the prison house begin to close
> Upon the growing Boy."

The ill-conditioned body, anæmic complexion and undersized muscles, or the fat and gross habit, the decay of the teeth, the disordered digestion, the nervous irritability and unhappiness are the result of "Nurture"—not Nature.

In institutions children may be disciplined to vigorous health. After leaving school they are set adrift to face monotonous work in confined places, amusement in music-halls and cinema shows in place of manly exercise in the open air, injudicious diet, alcohol, and tobacco—everything which the trainer of an athlete would repel.

> "And custom lie upon him with a weight
> Heavy as frost, and deep almost as life."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SHEFFIELD.—The council of the University of Sheffield has made the following appointments:—(1) Dr. H. R. Dean, to the Joseph Hunter chair of pathology, in succession to Prof. J. M. Beattie, who has been appointed to the chair of bacteriology in the University of Liverpool. Dr. Dean is at present assistant bacteriologist to the Lister Institute of Preventive Medicine. (2) Mr. Leonard Southerns, to the post of junior lecturer and demonstrator in physics, *vice* Dr. J. Robinson, resigned. Mr. Southerns is at present chief assistant at the Eskdalemuir Observatory, N.B. The council received the resignation of Prof. F. W. Hardwick of the professorship of mining, owing to his retirement from active work. Prof. Hardwick has been on the staff since October, 1891.

A COURSE of fifteen lectures on Indian sociology will be delivered at East London College (University of London), Mile End Road, E., by Mr. T. C. Hodson (late of the Indian Civil Service), on Wednesdays at 5.30, commencing October 23. The lectures are open to the public without fee.

DR. A. N. WHITEHEAD, F.R.S., University reader in geometry, will deliver at University College, London, a non-technical course of lectures on "The General Ideas of the Science of Geometry" during the first two terms of the session. The course will begin on Tuesday, October 8, at 5 p.m.

THE opening of the session at Edinburgh University will see the inauguration of the new scheme for engineering degrees by which the full resources of the University and the Heriot-Watt College are utilised for the first time to enable students to specialise in the three departments of civil, mechanical, and electrical engineering.

A REUTER message from Cape Town states that in view of the fact that there is no precedent for the Sovereign's holding office in any university of the Empire, the King has resigned the Chancellorship of the Cape University with which his Majesty was invested on the occasion of his visit to South Africa in 1901 as Duke of Cornwall. The Duke of Connaught has accepted nomination to the Chancellorship in succession to the King.

ANNOUNCEMENT is made of two courses of post-graduate lectures to be delivered at University College (University of London), by Prof. J. A. Fleming, F.R.S. (Pender professor of electrical engineering). One course, on "Electromagnetic Waves and the Theory of Electrons," will be delivered on Wednesdays at 5 p.m., beginning Wednesday, November 6, and the other, on "Electric Wave Wireless Telegraphy," will begin on Wednesday, January 22, 1913.

AT the University of Bristol, the calendar of which for the session 1912–13 has been received, the bachelor's degree can be taken in engineering, both by day and evening students. The final part of the curriculum may be in civil, mechanical, electrical, or motor-car engineering. At Bristol also, it is interesting to note, the Senate of the University is authorised to confer a testamur in social study and in journalism—a further indication of the desire of the modern university to assist directly every kind of professional work.

THE best criterion of the vitality of a university is the record of its members' contributions to knowledge. The magnitude of such a list cannot, of course, be taken as a measure of the importance of the original work accomplished, but it indicates the activity of the various departments of the university to which the list refers, and shows that attention is not being concentrated unduly upon examination standards. A list of memoirs, papers, &c., published during the years 1909–1912 by members of the teaching staff, scholars and fellows, research students, and others connected with the University of Glasgow has just been received, and it provides convincing evidence of the large amount of literary and scientific work published by members of the University. The uniform distribution of these products through all departments should be a particular cause of gratification to the principal.

THE needs of students of applied science receive increasing attention year by year from university authorities in different parts of the country. The new calendar of Armstrong College, Newcastle-upon-Tyne, one of the constituent colleges of the University of Durham, shows that here, for example, students, in addition to being able to obtain the degree of bachelor of science in pure science, may, if they prefer, offer instead one of seven branches of applied science. Degrees may, in fact, be obtained in agriculture, mechanical and marine engineering, electrical engineering, civil engineering, naval architecture, mining, or metallurgy. The calendar shows, too, that the active cooperation of engineering and shipbuilding firms in the district has been secured. Many manufacturers have promised to cooperate with the college by receiving pupils in the several departments of their works and in their drawing offices, and by permitting them to devote themselves exclusively during two or three sessions to their college studies.

THE prospectus for the session 1912–13 of the day and evening college for men and women at the South-Western Polytechnic, Chelsea, serves excellently to illustrate the very complete provision for higher education provided by the London polytechnic institutions. In both the day and evening classes at Chelsea students can prepare for degrees at the University of London under favourable conditions. In the day college those students who enter for technical instruction should have received previously, the prospectus points out, a sound English education and should have acquired an elementary knowledge of mathematics, and, if possible, of physics and chemistry. The courses are arranged to occupy three years. On entering the student states whether he wishes to be trained as a mechanical or electrical engineer, or as a consulting or industrial chemist. In any of these cases he will find mapped out for him a complete course of study, involving laboratory instruction and instruction in the workshops. Students, having completed a three years' course, should be in a position to obtain situations, in many cases without payment of premium, in important industrial firms. Similarly in the evening classes, instruction is provided in a wide range of scientific, technological, and other subjects.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 23.—M. A. Grandidier in the chair.—E. L. **Bouvier**: *Caridinopsis chevalieri,* and the genera of the Atyideæ peculiar to tropical Africa.—Henri **Douvillé**: The Orbitolines and their connections.—A. **Verschaffel**: The earthquake of the night of September 14–15, 1912. An account of the phenomena observed at the Observatory of Abbadïa.—**Claude** and **Driencourt**: The orthostathmescope or intrument for observing the passage through the zenith of the alignment of two stars on the celestial sphere.—Th. **De Donder**: The invariants of the calculus of variations.—N. **Lusin**: The absolute convergence of trigonometric series.—F. **Briner** and E. L. **Durand**: The conditions of formation of nitrous and nitric acids starting from the oxides of nitrogen and water; application of the law of mass action. Nitric oxide was compressed with solutions of nitric acid of varying concentrations; a general account of the changes noted is given, full details being reserved for a later paper.—Félix **Robin**: The crystallisation of metals by annealing. The metals examined included tin, lead, zinc, aluminium, copper, and iron. The grain developed by annealing was studied by etching with suitable liquids and microscopic examination.—H. **Jumelle** and H. Perrier de la **Bathe**: The cabbage palm of Madagascar.—M. **Chaillot**: The biology and anatomy of Labiates with subterranean stolons.—A. **Desmoulière**: The antigenic bodies in the Wassermann reaction. An account of the effects of the addition of cholesterol to the alcoholic extract of syphilitic liver. The sensibility and keeping powers are increased.—Maurice **Piettre**: The influence of some chemical compounds on the artificial melanines.

BOOKS RECEIVED.

The Simple Carbohydrates and the Glucosides. By Dr. E. F. Armstrong. Second edition. Pp. viii+171. (London: Longmans, Green and Co.) 5*s.* net. (Monographs on Biochemistry.)

Oxidations and Reductions in the Animal Body. By Dr. H. D. Dakin. Pp. viii+135. (London: Longmans, Green and Co.) 4*s.* (Monographs on Biochemistry.)

The Teratology of Fishes. By Dr. J. F. Gemmill. Pp. xvii+74+xxvi plates. (Glasgow: J. MacLehose and Sons.) 15*s.* net.

Wild Flowers as They Grow. Photographed in Colour direct from Nature. By H. Essenhigh Corke, with descriptive text by G. Clarke Nuttall. Fourth series. Pp. viii+300. (London: Cassell and Co., Ltd.) 5*s.* net.

Mind and its Disorders. By Dr. W. H. D. Stoddart. Second edition. Pp. xvi+518. (London: H. K. Lewis.) 12*s.* 6*d.* net.

South America: Observations and Impressions. By James Bryce. Pp. xxv+611. (London: Macmillan and Co., Ltd.) 8*s.* 6*d.* net.

Greek Sculpture: One Hundred Illustrations. By J. Warrack. Pp. xxx+plates. (Edinburgh: O. Schulze and Co.) 3*s.* 6*d.* net.

Twelve Moons. By F. A. Bardswell. Pp. 91. (London: Elkin Matthews.) 2*s.* 6*d.* net.

Radnorshire. By L. Davies. Pp. xi+156. (Cambridge University Press.) 1*s.* 6*d.* (Cambridge County Geographies.)

Celluloid: its Manufacture, Applications, and Substitutes. By Masselon, Roberts, and Cillard. Translated from the French by Dr. H. H. Hodgson. Pp. xx+356. (London: C. Griffin and Co., Ltd.) 25*s.* net.

Modern Mine Valuation. By M. H. Burnham. Pp. xi+160. (London: C. Griffin and Co., Ltd.) 10*s.* 6*d.* net.

Leuchtende Pflanzen. By Dr. H. Molisch. Zweite Auflage. Pp. viii+198. (Jena: Gustav Fischer.) 7.50 marks.

Legends of Our Little Brothers: Fairy Lore of Bird and Beast. Retold by L. Gask. Pp. 268. (London: G. G. Harrap and Co.) 3*s.* 6*d.* net.

Modern Problems. By Sir Oliver Lodge. Pp. vii+320. (London: Methuen and Co., Ltd.) 5*s.* net.

Treatise on General and Industrial Inorganic Chemistry. By Dr. E. Molinari. Third edition. Translated by Dr. E. Feilmann. Pp. xvi+704. (London: J. and A. Churchill.) 21*s.* net.

The Birds of Africa. By G. E. Shelley. Vol. part ii. Pp. viii+165–502+plates. (London: H. Sotheran and Co.) 1*l.* 11*s.* 6*d.* net.

CONTENTS.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

NO. 2241, VOL. 90] THURSDAY, OCTOBER 10, 1912 [PRICE SIXPENCE

Registered as a Newspaper at the General Post Office.]

THURSDAY, OCTOBER 10, 1912.

FIVE NEW SCHOOL GEOGRAPHIES.

(1) *Cambridge Geographical Text-books—Intermediate.* By A. J. Dicks. Pp. xi+362. (Cambridge: University Press, 1912.) Price 3*s.*

(2) *Physical Geography for South African Schools.* By Alex. L. Du Toit. Pp. xii+250. (Cambridge: University Press, 1912.) Price 4*s.* 6*d.* net.

(3) *A Geography of Europe.* By T. Alford Smith. (Macmillan's Practical Modern Geographies.) Pp. xi+272. (London: Macmillan and Co., Ltd., 1912.) Price 2*s.* 6*d.*

(4) *A Class Book of Physical Geography.* By A. T. Simmons and E. Stenhouse. Pp. viii+436. (London: Macmillan and Co., Ltd., 1912.) Price 4*s.* 6*d.*

(5) *The Marlborough Country.* Notes, Geographical, Historical and Descriptive, on Sheet 266 of the One-inch Ordnance Survey Map. By H. C. Brentnall and C. C. Carter. Pp. 171. (Oxford: University Press; London: Henry Frowde, 1912.) Price 2*s.* 6*d.* net.

THESE are five up-to-date geographies, each emphasising, more or less, the chief features of what has now for the last seven or eight years come to be known as the "New Geography."

(1) The Cambridge "Intermediate" is a general geography. It is worked on the lines of cause and consequence, the why and the wherefore. Each section dovetails into its immediate predecessor in logical order, thus:—

(*a*) Mathematical geography and relation of land and water *lead to* climate;

(*b*) Climate *leads to* flora and fauna;

(*c*) Flora and fauna *lead to* distribution of population, development of industry, &c.

These three divisions occupy one-eighth of the book proper. The remaining seven-eighths applies the principles enumerated to the great continental regions of the world in the old-time order—Europe, Asia, Africa, Australasia, America. This is exclusive of a large supplementary list of examination questions, and of a fairly copious index of place names. The questions are not all that could be desired. Too many are merely essay subjects, as "Of what value is the study of geography?" and "Write an essay on the German people, and their position in Europe at the present time." Some of the statements in the text, too, require qualification, *e.g.*, that the trans-Andine railway runs *through* the Uspallata Pass, and that the Egyptians belong to the Hamite race.

(2) Offers the usual contents of a physical geography—earth, air, water, fire, land-forms and life—but draws its examples, as well as its pictures, from South Africa, and adds a concluding chapter on the physical geography of South Africa itself. Its strong point is its geology, which becomes the weak point of its geography—for there is far too much of it. The human interest suffers. This appears to be a defect throughout. There is a maximum of man's environment and a minimum of its effects on man himself. The value of the book to *English* teachers will lie in the novelty of the South African examples, which at once takes it out of the ordinary run of our school books. Its style strikes one as very stiff for class work, and there are no exercises. A full, if somewhat pretentious, bibliography is given at the end.

(3) Attacks the regional geography of Europe on modern lines. The various "lessons" consist of (*a*) practical exercises, (*b*) descriptive matter, (*c*) questions. Teachers who know Macmillan's "Practical Modern Geographies," of which series this is one of the latest volumes, have nothing but praise both for the matter and for the method of the books. In dealing with Europe regionally, it is, of course, impossible to ignore the political divisions, but Mr. Alford Smith rightly lays great stress on their physical bases.

A special instance will show the method of treatment. Chapters xiv.–xviii. are allotted to Germany, and are headed: Climate and Vegetation, Races of People, Coalfields, The Rhine, North Sea Ports—five headings which pick out the salient features of the country. To ensure the inclusion, or at all events the non-exclusion, of the other features, practical exercises are added on allied subjects, *e.g.*, distribution along with races of people, manufactures with coal, commerce and trade with ports.

(4) An excellent book treats physical geography as an intensely practical subject. Here, too, exercises, descriptions, and questions follow each other. The value of an exercise lies in its stimulus for investigation; the boy must use his school atlas, his book of reference, his instruments. He must become, therefore, to a certain extent an independent observer—which is excellent, and very satisfactory to all concerned, and is the very *raison d'être* of all books of this type. But to work out his exercises he must be assisted here and there with *clear* accounts of geographical phenomena. The authors of this physical geography are to be congratulated on the clarity of their descriptions. The section on winds, even though "wind roses" may not give a wholly correct idea of the winds of a given district, may be turned to as an example. He would be a dull boy, or girl, who could not grasp the principles of

the monsoons and the influence of the heat equator from these pages.

(5) "The Marlborough Country" should be as interesting to a tourist with a bent for geology, or archæology, or nature study, as it is useful to a teacher who wants to deduce from an ordnance map the immense amount of information which lies hidden beneath its signs and symbols. The Marlborough district map (sheet 266 of the one-inch ordnance survey map) is in this little book made to yield up as subject-matter for observation the reading of relief maps in general, the physical divisions of the "Marlborough Country," its geology, climate, farm life, communications, distribution of population, history and archæology, let alone such specialities as the Downs, the Vale of Pewsey, Savernake Forest, and a host of miscellanous local topics. The book is a novelty, and has more than a local interest. It is a pioneer, an exemplar, in the science of home geography.

Summarising generally, all five books are suitable for the middle and higher forms of a secondary school. No. 1 is well got up, of taking appearance, but rather sketchy, and inferior, in our opinion, to its "Oxford" rivals. No 2 must fill a great void in South Africa, but is naturally not so well adapted for British schools. Nos. 3 and 4 are on similar lines, and belong to the excellent type of book of which Simmons and Richardson's "Introduction to Practical Geography" was the first exponent. No. 5 has for its staple just the kind of information that a guide-book relegates to its introductory pages, and as for its interjectory questions—well, the ordinary man may ignore them, while the teacher will find them extremely useful.

LABORATORY CHEMISTRY.

(1) *Outlines of Inorganic Chemistry.* By Dr. E. B. Ludlan. Pp. xv + 365. (London: Edward Arnold, 1911.) Price 4s. 6d.

(2) *A Handbook of Organic Analysis, Qualitative and Quantitative.* By Hans Thacher Clarke, with an introduction by Prof. Norman Collie, F.R.S. Pp. viii + 264. (London: Edward Arnold, 1911.) Price 5s. net.

THE methods of teaching chemistry, particularly inorganic chemistry, are so diverse and depend so much upon the individuality of the teacher that it is no wonder there are a large number of books on elementary chemistry, and that their number is still increasing.

(1) Mr. Ludlan's book is very readable, and is illustrated with portraits of Lavoisier, Priestley, Scheele, Faraday, Dalton, and Humphry Davy. We like the introduction of such portraits in a book on science because it helps the student to remember historical facts, and impresses upon his memory the importance of the work of the persons whose portraits appear.

The author commences with a brief discussion on early notions which for many reasons, mainly for the want of the balance, were incorrect. The moral impressed is: "Be sure of your facts before trying to explain them." Some of the questions at the end of the chapters are unusual; for example, "How would you attempt to establish the truth or inaccuracy of the following statements: 'Sunshine puts the fire out'; 'Sunshine makes colours fade'; 'A watched kettle never boils'?" These questions may be suitable in a class, but are somewhat puerile in a book, more particularly as the chapter in question does not deal with them—it happens to be "On the Rusting of Iron." But anyone who works carefully through the book will obtain a good foundation of elementary chemistry.

(2) The second book is of a very different character, being on organic analysis. It is only fairly recently that books on organic analysis have been published in which any attempt has been made at classification. Of course, the difficulties of classifying substances of such diverse nature and properties as occur in organic chemistry are very great, and when all is said and done organic analysis is not in general so exact as inorganic analysis.

Prof. Collie, who writes an introduction to the book, remarks that "The examination of inorganic ions too often tends to degenerate into a series of arbitrary tests, memorised and applied without much consideration of their theoretical bearing." Some years ago, when everything was worked by the "chart," this was to some extent true, but the more modern books almost always insist most strongly on a mastery of the theoretical as well as the practical aspect. It is a strange fact that an organic chemist is apt to think lightly of inorganic chemistry and *vice versa*, and yet each branch has its own difficulties and importance.

The first chapter of the book before us deals with the preliminary investigation of the substance or substances to be analysed. Tests for purity, such as melting point, boiling point, and fractionation, are enumerated—we say enumerated instead of given, because the description is rather inadequate; for example, Distillation under reduced pressure: this is followed by tests for carbon and hydrogen and further preliminary tests with the object of sorting into groups such as phenolic, acidic, neutral, &c. The next chapter deals with the examination for radicles; it is well written, and the facts are grouped together in a very useful manner. The third chapter practically completes the qualitative portion of the book, and is followed by tables of organic compounds in which the properties and physical constants of a large number of the most generally met with organic compounds are compiled—it is, in fact, a short dictionary. This section will most certainly be found very useful in the laboratory, and has been very painstakingly compiled.

The rest of the book deals with quantitative analysis, combustions, nitrogen determinations, vapour densities, optical rotation, and other methods which are employed in the laboratory.

LOCAL AND GENERAL GEOLOGY.

(1) *Transactions of the Paisley Naturalists' Society.* Vol. i. Notes on the Mineralogy of Renfrewshire. By Robt. S. Houston. Pp. 88. (Paisley: Alexander Gardner, 1912.) Price 2*s.* 6*d.* net.

(2) *Physiography for High Schools.* By Albert L. Carey, Frank L. Bryant, William W. Clendenin, and William T. Morrey. Pp. vi+450. (Boston, New York, Chicago: D. C. Heath and Co.; London: George G. Harrap and Co., 1912.) Price 4*s.* 6*d.*

(3) *Structural and Field Geology. For Students of Pure and Applied Science.* By Prof. James Geikie, F.R.S. Third edition, revised. Pp. xxiv+452. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson, 1912.) Price 12*s.* 6*d.* net.

(1) MR. HOUSTON'S volume, attractively produced and excellently printed, cannot fail to arouse interest in local mineralogy. A preface is given on the geology of Renfrewshire, and we are reminded of the famous specimens of prehnite and analcite from the Boylestone Quarry, near Barrhead. New analyses are given of several minerals, including phosphatic nodules (p. 72) from three localities, and a greenish kaolin (p. 71). The name "lithomarge" is misprinted in three places, and we do not like the term "carbonated" on p. 78 in place of "carbonised." But considerable care has evidently been given to the book, which serves as a model for the work of local naturalists.

(2) We now possess several good English books on physiography, and have received much stimulating aid from the United States. Hence it is questionable if another American work is likely to find a free place in our schools. Four high-school masters, however, have collaborated in New York City in producing a clearly written account of natural phenomena, illustrated with views and maps from the wide field available in the United States. Unlike Huxley, they set aside the biological aspects of physiography, and they omit in consequence a good deal that would interest a schoolboy in the surface-features of his country. The work is terse and lucid, but seems somewhat cold and uninspiring; its method of construction has prevented any one of the authors from impressing on it the mark of personality. A few good books of scientific travel would probably set young pupils thinking to far more purpose about the earth. Physical geography in the high-school stage already runs the risk of becoming stereotyped. Certain set names for phenomena require certain definitions. Meanwhile, the rock is removed out of its place and the waters wear the stones, while the eye of the pupil, made for wonder, remains fixed upon the printed page.

(3) Prof. James Geikie's "Structural and Field Geology" now reaches a third edition. In its fine use of full-page photographic plates it aims at accurate illustration of what will be encountered in the field. No one can convert these pictures into diagrams for the note-book; they are, as the author intends, direct encouragements to observe. Rocks are photographed from actual specimens, and the landscapes and field examples are largely derived from the series of views brought together by the Geological Survey. The book is a broad treatise on physical geology, written with a remarkable absence of technicalities. It goes, perhaps, too far in avoiding chemical considerations, such as those involved in the formation of laterite (p. 58) and cornstones (p. 70), and in omitting even chemical formulæ, which would be helpful in the description of the silicates. Methods of testing minerals and rocks are introduced as they happen to be required, and it is clear that the work should be read continuously. Among its best features are the drawings of block-models of faulted strata (pp. 162 and 166), which explain many of the puzzles of geological maps. The trough-faults in Fig. 53 might gain by a cross-reference to their explanation in Fig. 54.

The principles of geological surveying receive unusually full treatment, and attention is given to economic questions and to the broad characters of soils. Chapter xxv., on geological structure and surface features, might, of course, be greatly elaborated. The twenty-three lines devoted to coast-lines seem inadequate in comparison with forty-five pages given to ore-formations in chapter xvi., a subject not closely related to structural geology. Prof. James Geikie's book, so handsomely set before us, will long remain our best introduction to geological phenomena as they actually present themselves to the observer.

Grenville A. J. Cole.

WHAT IS INSTINCT?

The Evolution of Animal Intelligence. By Prof. S. J. Holmes. Pp. v+296. (New York: Henry Holt and Co., 1911.)

THE study of animal behaviour has two problems, description and interpretation. Both give opportunities for error. Thus on the one hand Binet's discussion of the mental life of Protozoa is largely based on a mistaken view of the facts. Didinium does not "hunt" its prey or "cast darts" at it. On the other hand Thorndike, on the basis of his well-known experiments, argued that his animals showed no high degree of intelligence because there was no sudden drop in their learning curves; Hobhouse opposed this conclusion on the ground that the curves did show a sharp drop. But in a recent article comparing human adults, children, and rats in learning a maze, Prof. Hicks finds that "the relation between the abruptness of slope and the degree of rational ability is just the inverse of that assumed by Thorndike and Hobhouse."

As this example suggests, problems of interpretation lead inevitably to questions of human psychology. Now we know considerably less about human methods than the old naïve anthropomorphism assumed. Nevertheless, the work already done by general psychology upon many of the problems of interpretation occurring in animal psychology cannot profitably be ignored. The failure to recognise this fully somewhat detracts from the value of Mr. Holmes's discussion of that central problem, the nature of instinct. His treatment seems to imply that the distinction between reflex action and instinct is merely one of degree or complexity.

Spencer's view is, of course, one for which many arguments may be found, but, in any attempt to discuss the matter at all fully, it should surely be made clear that a very different opinion has been taken by most of those approaching the question from the psychological, rather than the biological, viewpoint the opinion, namely, that instinct is essentially conscious, involving elements of striving, feeling and cognition. Curiously, Mr. Holmes quotes with approval a well-known passage from James which insists on the essential kinship of animal instincts with human impulses, without apparently seeing how incompatible this conception is with any attempt to define instinct in terms of mere movement. Certainly, unless all interpretation is delusive, it seems clear that in many cases consciousness is necessarily involved. A bird building a nest or feeding its young is not merely executing a series of movements which happen to produce a given result. On different occasions this result remains the same while the exact movements and their order are continually varying; that is, the result is not merely an effect but also a cause: we have not merely movement but action.

In discussing puzzle-box tests of intelligence Mr. Holmes rightly agrees with Prof. Hobhouse that the frequent variation of method in lifting the latch, &c. (*e.g.*, using either paw), is conclusive against attributing everything to sensori-motor association. But the same argument seems decisive against regarding instinct as a complex of reflexes. Its framework is fixed; the gaps, however small, have to be varyingly filled in by conative and intellectual processes of at least the perceptual level.

Into the relation of instinct to intelligence it is impossible to enter. The use of intelligence as equivalent to the power to form associations may be justified if one means merely that which is opposed to instinct, but it fails to find any place for that perception of relations which is to be found selecting means to ends whether given by congenital or experiential orientation.

If Mr. Holmes's discussion of central theoretical questions is not altogether satisfying, his book is extremely interesting if only because of the amount of concrete illustration. It is unfortunate that a number of slipshod phrases has been allowed to pass.

OUR BOOKSHELF.

Their Winged Destiny, being a Tale of Two Planets. By Donald W. Horner. Pp. 240. (London: Simpkin, Marshall and Co., Ltd.) Price 2s. net.

THERE are about one hundred million suns in space; and it is reasonable to suppose that many of them have planets revolving round them similar to those which form our own solar system. Whether life exists upon any of these bodies is a matter of legitimate speculation. It is, perhaps, possible that among so many bodies there is one which has gone through precisely the same stages of development as the earth, and upon which the same forms of life are in being. This hypothesis provides Mr. Horner with the basis of his fantastic romance.

As in Mr. Wells's impressive story of "The Star," a new star appears and threatens to destroy the earth. To avoid the calamity, a party leaves the earth in an "Electronship," which can travel with the velocity of light, and after four years arrives at the system of α Centauri, where black and white giants were at war on one planet, while another was found to be exactly like the earth, not only as regards the distribution of land and water, but also in its inhabitants, who spoke the same languages as the peoples of our globe. Slight differences of mechanical and social development led to difficulties when the travellers settled down upon the Centaurian planet; and eventually the party returned to the earth again to find that it had not been annihilated, the new star having passed outside our system.

There is, of course, a love story to give human interest to the adventures; and some amusing and exciting episodes lighten the monotony of a tiresome journey. As an attempt to combine fact with fiction, the story is not without merit; but the style is commonplace, and such a split infinitive as "to quietly and unostentatiously do" is enough to make any lover of good literature shudder. R. A. G.

Catalogue of the Periodical Publications in the Library of the Royal Society of London. Pp. viii+455 (London: Printed for the Royal Society at the Oxford University Press and sold by Henry Frowde, 1912.)

Catalogue of the Periodical Publications, including the Serial Publications of Societies and Governments, in the Library of University College, London. By L. Newcombe. Pp. vii+269. (Oxford: Printed for University College, London, by Horace Hart, 1912.)

The general plan of both these catalogues is similar, and this is natural, since the Royal Society catalogue has been compiled by Mr. Newcombe, sub-librarian of University College, London, and Mr. L. Ellston.

A catalogue of periodical publications in the library of the Royal Society was last printed in 1881, and the large number of accessions to this section of the library in the succeeding thirty years rendered a new catalogue imperative. Instead of adopting the plan of the old catalogue, with its classification under eight separate alphabets, the present has been arranged under one alphabet and restricted as closely as possible to periodical works.

The catalogues will prove invaluable to scientific workers who make use of either library, for the task of discovering a volume has certainly been made as light as possible.

Bacon's New Globe with Contour Colouring. Natural Scale 1/37,000,000. Price 25*s.*

The globe is nearly fifteen inches in diameter, weighs about four and a half pounds, and is consequently easily portable. It is provided with a brass graduated semi-meridian and a conveniently-arranged compass. The colour scheme is based on that of the International Map Committee, and the relative land levels and sea depths are both indicated.

The large number of names included has made the size of type very small, and few places can be read even at a short distance. This will interfere with the use of the globe for class purposes. For individual study the globe will prove useful, and its use may be recommended to correct the wrong impressions formed by an exclusive examination of flat maps.

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.]*

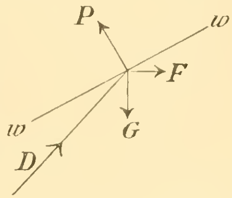
Sailing Flight of Birds.

Coming out from Queenstown on September 10 on her way toward Boston, the ss. *Arabic* was accompanied for some hours by a large flock of gulls. For the most part these birds were visibly working, flapping their wings, but occasionally a few would cease flapping and merely sail along for considerable distances, keeping up with the ship or even gaining upon it, sometimes descending, sometimes ascending, apparently at will, with no perceptible action of their wings except, now and then, a slight effort which seemed to be needed for preserving equilibrium, not for support or for propulsion. The wind was of such direction and velocity that the smoke from the ship's funnel went astern in a trail making an angle of, perhaps, 30° with the keel.

Having at first no reasonable theory of the sailing which the gulls practised, I watched them intently for some time, and made the following observations:—

(1) The sailing occurred almost wholly, if not quite so, over or near the windward side (the starboard) of the ship, at moderate heights, 20 to 40 ft. perhaps, above the level of the uppermost deck, and not very near the bow.

(2) When a bird was sailing parallel to the course of the ship, the line from beak to tail was very nearly, if not quite, parallel to the trail of smoke from the funnel. If the gull turned so as to make his own axis more nearly parallel to the keel of the ship, he drifted to leeward; if his axis was turned somewhat farther from the direction of the keel than at first, he went to windward.



Apparently the head and neck served as a bow rudder for small changes of direction, the whole body soon following the course indicated and initiated by this part.

(3) When a bird was sailing along with the ship his head was held rather low. If he raised his head and lowered his tail, he was carried to leeward or astern with great velocity; this frequently happened, for it was evident that most of the food was discovered by the gulls behind the sailing ones, and the greater part of the flock was usually there.

(4) When, through a shift in the wind or in the course of the ship, the smoke began to trail out nearly astern, a change which occupied a few minutes only, the sailing of the birds ceased, each one being then obliged to make visible effort to keep up with the ship.

An explanation of the ability of the birds to sail, under the conditions described above, is, I believe, found in the upward course of the wind which has struck the weather side of the ship and must rise in order to pass over it. Given a brisk, steady, upward current of air, a gull, with its highly practical knowledge of mechanics, can, of course, sail in any direction. Thus, in the figure here given, if *ww* represents a wing-plane, D the direction of the current of air, P the net wind-pressure on the wing-plane, G the pull of gravity, the bird's weight, and F the frictional resistance[1] encountered by the bird in moving through the air, we have indicated a solution of the problem of support and of propulsion, propulsion in a direction opposite to that of the horizontal component of the wind's velocity.

As the trail of smoke marks the direction of the wind with respect to the moving ship, the bird must, in order to sail with the same velocity and direction as the ship, have a motion relative to the air equal and opposite to the motion of the smoke relative to the ship. Accordingly, the bird's axis is kept parallel to, and opposite to, the course of the smoke as indicated by its trail from the funnel.

With a head-wind, though there must be an up-current near the bow, this current must be much more narrowly local, and therefore less advantageous for the bird's use in sailing, than the up-current produced by a wind abeam.

It would appear that the gulls when sailing are not directly seeking food, but are merely resting, loafing for the time being, with ears intent, however, for any indication of a find by their more industrious brothers astern.

Having shown this discussion to a number of well-known physicists aboard the *Arabic*, I find no opposition to the theory proposed for the facts as noted, but a very general doubt as to whether gulls do not sometimes sail on the leeward side of a ship or too far astern to get the benefit of the upward air current from the windward side. When I ask seafaring men about the matter, they at first say confidently that the birds sail on either side of the ship, but after a little consideration they waver in this statement and admit that they have never taken particular note of the facts in the case. Accordingly I have thought it worth while to write this letter, in the hope that its publication in NATURE, if room be found for it, may stimulate further observation of an interesting phenomenon and perhaps prevent some inventors from wasting their time and money in vain attempts to accomplish motor-less flight.

The westward course from Queenstown may be an especially favourable place for studying the question here raised. Four years ago I made there some observations which, so far as I can now recall them, agreed in essential particulars with those which I have made recently, but I did not at that time see the full significance of the facts noted.

EDWIN H. HALL.

Cambridge, Mass., September 20.

[1] Perhaps D should be taken in the direction of D, but uncertainty here does not affect the main argument.

Errors of the Computed Times of Solar Eclipse Phenomena.

THE final reports of two of the observers of the total solar eclipse of April 28, 1911, have recently been published, giving detailed accounts of their experiences at Vavau, Tonga Islands. Father Cortie's report appears in Proceedings, R.S., No. A595; that of Dr. W. J. S. Lockyer in a publication of the Solar Physics Committee. In reading these reports I have been much struck by the circumstance that both writers appear to have been taken aback by the (to them) unexpected effect of the errors of the lunar tables on the computed times of the various phases of the eclipse. But I wish to point out that they were not left without warning. In Monthly Notices, R.A.S., vol. lxix., p. 31, I stated that with the existing errors of the lunar tables the times of the contacts in this eclipse as there given would be several seconds too late. And as a means of estimating the true times I gave the intervals from the instant when the cusps subtended an angle of specified value at the sun's centre to the commencement of totality. The shift of the moon's actual position relatively to its tabular place would, of course, alter the predicted duration of the eclipse. At the time of publication of my paper (November, 1908), it was not possible to give definite information as to the magnitude of the errors in question, as Newcomb's latest corrections were not then available. But, so far as appears from these reports, the intending observers did not make any further inquiries on the subject before proceeding to draw up their definite programmes of observation. In the circumstances this, surely, would have been a wise precaution.

A. M. W. DOWNING.

September 27.

WITH regard to Dr. Downing's remarks, I was aware from his published statement that the predicted time of totality would probably be "several seconds too late," but little thought that the error would amount to so much as *twenty seconds* of time. The precaution was naturally taken to observe closely the diminishing cusp and to arrange to give the necessary time signals from the cusp data mentioned by Dr. Downing in the above letter. Unfortunately, however, while the cusp was visible nearly up to second contact, the image of it on the screen had been oscillating so violently (due to air tremors) that the officer in charge had previously decided to give the necessary signals at the computed times from the chronometer. (See page 17 of my report for details of the actual procedure.) It is true that no inquiry was made by me to find out what error might be expected, but it was assumed that if such a large error had been approximately known it would have been published. It would be advantageous if the present director of the Nautical Almanac could find his way to make generally known the approximate values of such errors a short time previous to the setting out of eclipse expeditions.

The facts that Father Cortie's camp was in the same clearing as that of my party and that he made use of my time signals explain why he experienced the same error.

WILLIAM J. S. LOCKYER.

Solar Physics Observatory, October 1.

A Flower-sanctuary.

IT seems to me that Sir Edward Fry takes a rather narrow view of the by-law under discussion; for surely it may be held that the removal of any of the special Cheddar plants, in such quantities as to leave a blank where there was formerly a mass of colour, would constitute a "disfigurement" or "damage" within the meaning of the enactment: and I suggest that any bench of magistrates anxious to preserve the beauty of the gorge should find no difficulty in convicting under the by-law. If, however, it be held that the existing by-law is inadequate, it seems clear that county councils have full power to enact far more stringent and specialised by-laws.

I remember that on the commons under the jurisdiction of the London County Council there used to be—and doubtless still are—notices forbidding anyone, under a penalty of five pounds, to pluck even a single blossom of any wild flower; and I think that Sir Edward Fry will find on St. Vincent's Rocks, at Clifton, notices announcing a similar penalty against anyone who shall gather the rare *Arabis stricta*: at any rate, there were such notices a few years ago, and it was well understood that the protection of *Arabis stricta* was the motive, or a chief motive, of the authorities. FRANK H. PERRYCOSTE.

Higher Shute Cottage, Polperro, Cornwall, September 29.

MR. PERRYCOSTE is quite right in suggesting that the special flora of Cheddar might be destroyed in such a way as to bring the offender under the by-law in question, but this does not interfere with my statement that the flora might be destroyed without any contravention of the by-law; it is much more probable that the flora will be gradually extinguished than by a single act of vandalism. EDW. FRY.

IN addition to the existence of a local order for the protection of wild flowers in Cornwall, extending only to the highways, there are other counties, such as Essex, Surrey, Sussex, and Devon, that have already availed themselves of the power to frame a by-law applying to a separate county.

Though these means of restricting hawking and excessive collecting exist on a limited scale at present, it is the aim of the Plant Protection Section of the Selborne Society to obtain the cooperation of all county councils in the framing of by-laws throughout the country. This, indeed, it must be stated, is apparently the only course left, for the experience of county councils in applying singly for this power to the Home Office has been distinctly discouraging. In fact, the Home Office has refused to increase the number of local orders; so that the only method to adopt is to get every county council to apply simultaneously, when the force of public opinion thus expressed will not fail, we hope, to have the desired effect.

Of course, the securing of a local order for Somerset, as advocated by Sir Edward Fry, would not be equivalent to the establishment of a flower-sanctuary. Unless land were purchased by the National Trust, or some kindred public-spirited body, or by private enterprise, the making of a reservation of any tract without the owner's consent is out of the power of the Government. At least, we have not come to land nationalisation as yet (save the mark!).

The desirability of the formation of wild-flower reservations is undeniable. It is one of the projects kept in view by the Plant Protection Section. One of the methods of securing this end will be the obtaining of the support of the scientific societies of the country, and the appointment of a corresponding secretary in each district to advise upon what tracts require reservation and what facilities exist locally for their formation. The writer's investigation into the voluminous causes of extermination of plants has shown that there are numerous localities in every county of the British Isles which require reservation or protection. It is obvious that no one body such as the Selborne Society could undertake to carry on single-handed the enormous amount of organisation required to protect actively plants locally without effective assistance from such bodies, or without some organised effort. This question is on the *tapis* at the next meeting of the section, which I hope Sir Edward Fry will attend, and it is hoped to prosecute this part of the campaign very actively during the coming winter. The assistance of any who can render service in this matter of enlisting the sympathies of the scientific societies will be very gratefully received. The result of an appeal to the county councils last year to aid in the creating of a public protest against exterminating wild flowers, especially addressed to the schools, in which the collecting necessary to the pursuit of nature-study was involved, was very encouraging.

The whole question resolves itself, in fine, to the obtaining of State protection of wild plants (and animals) in this country, as in Prussia. This is the prime object the section has in view. In the meantime, it is endeavouring to create a public opinion in favour of the movement, until such time as the occasion is ripe for making a concerted appeal for Government control. A. R. HORWOOD,

Recorder, Plant Protection Section of the Selborne Society.

Leicester Museum, September 27.

The Summer of 1912.

IN NATURE of September 19, Mr. Harding concludes a very interesting article on the recent summer in the British Islands, by recording the fact that "the temperature of the sea-surface in the North Atlantic and in proximity to our own coasts has for some time past been much below the average." This seems to bear out what I have been telling people for weeks past—that the abnormal chilliness of the past summer, and especially of the month of August, was in all probability due to the cooling of the Gulf Stream by the abnormal ice-drift on the other side of the Atlantic, to which the disastrous fate of the *Titanic* forced the tardy attention of even the great shipping companies. A reference to such a thorough-going atlas as that of Diercke and Gaebler (p. 21) will show what this must mean, when not only icebergs but extensive icefloes in such numbers were melting away in the latitudes of the Spanish peninsula, and even further south than the latitude of Gibraltar, in the very path of the Gulf Stream Drift, and even of the return North Equatorial current, with the natural result that these islands, within the same latitudes as Labrador, should have a taste of something like a Labrador summer.

If we make a little scientific use of the imagination, asking ourselves what would be the climatic results to north-western Europe of the obliteration of the Gulf Stream altogether, we may arrive at some inferential results as to the importance of such a causal factor among the conditions which existed in the Pleistocene period of glaciation, when—as Prof. J. W. Spencer (Bull. Geol. Soc. America, vol. vi.) has shown —the elevation of the Antillean Continent was such that we may infer the impossibility of the existence of the Gulf Stream as such for the greater part of that period.

That would leave us no more than such a mere *wind-drift* of surface ocean-water as is seen in the "Kuro-Siwo" of the North Pacific at the present time (*op. cit.*, p. 13). See further, Tarr, "Physical Geography" (pp. 182–191) and "The International Geography" (p. 69), both published by Messrs. Macmillan and Co. A. IRVING.

Hockerill, Bishop's Stortford, September 30.

Turkish Earthquake of September 13.

THE bulletin from Pulkowa has just reached me, and from this it appears that the azimuth of the epicentre from Pulkowa was 9° 12′ west of south. Two estimates of the distance are given, leading respectively to 41·1° N., 26·4 E., and 40·1° N., 26·3° E. The epicentre determined here was 40·4° N., 26·9° E., and the azimuth was 65° 33′ east of south.

From the two azimuths alone I find the epicentre to be 40·7° N., 26·5° E. GEORGE W. WALKER.

The Observatory, Eskdalemuir, Langholm, Dumfriesshire, October 1.

THE NORTHERN ELEPHANT SEAL.

A VALUABLE paper on the northern elephant seal (*Macrorhinus angustirostris*, Gill), by Mr. Charles H. Townsend, director of the New York Aquarium, has been published in "Zoologica"—scientific contributions of the New York Zoological Society vol. i., No. 8. The paper is No. 2 of the scientific results of the expedition to the Gulf of California, in charge of Mr. Townsend, by the U.S. Fisheries steamship *Albatross* in 1911. It consists of fourteen pages, accompanied by twenty-one illustrations, and relates to a species concerning which there has been comparatively little information obtained during the past forty years.

The northern elephant seal has long been on the verge of extinction, and is now found only on Guadalupe, an uninhabited island lying in the Pacific Ocean 140 miles off the northern part of the peninsula of Lower California. It formerly had a range extending for about 1000 miles along the coast of Upper and Lower California, and has never been recorded from any other region of the north Pacific. It is the largest of all seals, and owes its name to its great size and to the remarkable snout or proboscis developed in the adult male.

Being valuable for its oil, the seal was killed in large numbers for commercial purposes as late as the year 1852. Since then it has seldom been seen. During the winter of 1911, while in charge of the deep-sea investigations of the United States steamship *Albatross*, Mr. Townsend called at Guadalupe Island and was fortunate enough to secure the specimens, photographs, and data upon which the present paper is based. In addition to the museum specimens obtained, six yearlings were shipped alive to the New York Aquarium.

The seals had little fear of man. While the large specimens were being skinned and skeletonised, some of the animals slept undisturbed within thirty feet of where the men were working. A few of the females were accompanied by newly born pups, indicating that the breeding season was just commencing. The author did not observe any male with more than one female.

The three adult males which were killed were found to have an average length of sixteen feet, with a girth of eleven feet. The adult female obtained was eleven feet long. The new-born pups were distinguishable in colour from the yearlings, being dusky black, and were apparently about a week old (March 2). The colour of the adult is yellowish-brown, the young animals being greyish-brown.

The skin of the adult male is very thick, and the carcasses were so heavy that it required all the strength of half-a-dozen men to turn one of them over. Unless actually annoyed by members of the party, the animals did not attempt to leave the beach. The large males that accompanied the nursing females were frequently engaged in fights with unattached males. There had evidently been considerable fighting, as their necks were more or less raw.

In fighting, the large males crawl slowly and laboriously within striking distance, and then, rearing on the front flippers, and drawing the heavy, pendant proboscis into wrinkled folds well up on top of the snout, strike at each other's necks with their large canines. The skin of the under surface of the neck and fore-part of the breast is greatly thickened; it is practically hairless, and years of fighting give it an exceedingly rough and calloused surface. This *shield*, as it may be

FIG. 1.—View of north end of elephant seal rookery, Guadalupe Island. Males, females, two-year olds and yearlings. The males with heads erected are in fighting attitude, with proboscis retracted and mouth wide open. U.S.S. *Albatross* in distance.

called, is the part of the animal most exposed to attack when fighting. The proboscis is broad and fleshy to the tip, and its length forward from the canines is about equal to the distance between the canine and the eye. It is exceedingly thick and heavy, and its width is about equal to the space between the eyes. In one specimen taken, it was nine inches long. When the animal is crawling, the proboscis is relaxed and pendant.

The author found that the proboscis is not capable of inflation. When withdrawn, it is simply massed into compact folds on top of the head. There is little indication of the proboscis in the half-grown male, and it is probable that it does not develop until sexual maturity is reached.

The specific distinctness of the northern elephant seal is well shown in photographs of the skulls of *Macrorhinus angustirostris* and *M. leoninus*, the skulls of both species exceeding twenty-two inches in extreme length, *angustirostris* being longer, while *leoninus* has the greater zygomatic width.

Mr. Townsend has directed the attention of the Mexican Government to the existence of this unique herd, and the Mexican authorities have already taken steps to prevent its destruction.

FIG. 2.—Male elephant seals approaching to fight. When within striking distance, both rear high on fore flippers, retract proboscis and open mouth very wide.

THE NATURAL HISTORY OF THE DEAD SEA AND JORDAN VALLEY.[1]

IN the volume before us Dr. Blanckenhorn has collected the results of his researches into the geology and natural history of Palestine, the latest of which occupied the first half of 1908. These have enabled him to give a much more minute account of the geology of the region than any of his predecessors, to lay down more accurately the boundaries of the several formations, and to trace a number of important faults. As his map shows, the Syrian upland on either side of the Jordan valley from the southern end of the Dead Sea almost up to the Lake of Gennesaret consists of Cretaceous rocks chiefly of Senonian and Turonian age, with an occasional exposure of the underlying Cenomanian.

At the beginning of the Senonian were slight and local volcanic outbreaks, and this formation is sometimes bituminous. Marine deposits of Eocene age are first seen on the west side of the Jordan about the latitude of Jaffa, and become more extensive in proceeding northward. No marine beds of Miocene or Pliocene age occur in the hill country; the deposits in the Jordan valley are mapped as *diluvium* (when will foreign geologists abandon this discredited and misleading term?), and the latest therein, with those in the Kishon valley and on a large part of the coast, are "alluvium." Then came the volcanic discharges which built up the great basalt mass of the Hauran with the minor outbreaks west of the Jordan, which are obviously subsequent to the formation of its valley. On a separate sheet Dr. Blanckenhorn exhibits in a tabular form (very convenient to the reader) his conclusions in regard to the dates of the later movements and deposits, and their correlation with those in Europe. According to this, a continental elevation, causing a steeping of the general slope and the first great erosion-phase of the rivers, began about the middle of the Pliocene. Dr. Blanckenhorn places the second phase of earth movements, bringing about the first fractures running from north to south,

[1] "Naturwissenschaftliche Studien am Toten Meer und im Jordantal: Bericht über eine im Jahre 1908 unternommene Forschungsreise in Palästina." By Prof. Max Blanckenhorn. With geological map in colours, 6 plates from photographs, and 106 figures in text. Pp. vii+478. (Berlin: R. Friedländer & Sohn, 1912.) Price 1*l.* 4*s.*

i.e., the trough faulting which gave rise to the Red Sea and the Gulf of Akabah, the Wady Arabah and the Jordan valley, at the beginning of the Pleistocene, and with this he associates the great basaltic discharges already mentioned.

A large fresh-water lake was next formed in the Jordan valley, which he considers to be a record of a pluvial phase and contemporaneous with the Günz glaciation of the Alps. Towards the end of this began a third epoch of earth movements, producing some folding and faulting in a north to south and north-north-east to south-south-westerly direction and bringing up some older strata, among them probably the Cambrian, which he discovered south of the Dead Sea. These caused some more eruptions. A short dry period followed, in which the level of the lake was lowered, the water became brackish, and the salt beds of Jebel Usdum (the top of which is about 600 feet above the present level of the Dead Sea) were deposited. This corresponded with the first interglacial phase of the Alps. The Mindel glaciation of that region brought on a pluvial phase in Palestine when the Jordan valley-lake was at its greatest, extending from the north of the Lake of Gennesaret to some distance south of the Dead Sea, and small glaciers formed in the Lebanon. A long dry phase succeeded, corresponding with the second interglacial of the Alps, during which the Jordan lake sank nearly to the present level of the Dead Sea; all the valleys were much eroded, and some streams of lava (the last in this region) were ejected.

The Riss ice age of the Alps (that when the glaciers attained their greatest size) corresponded with a third pluvial phase which produced the middle terraces in the Jordan valley. The lake again retreated in another dry period, representing the third interglacial of the Alps, but the lower terraces in the Jordan valley are records of the Würm glaciation, after which the climate gradually changed to its present condition. Valley erosion went on throughout, and an elevation of the coast occurred just before the Würm ice age. This, according to Dr. Blanckenhorn, corresponds with the Mousterian, Aurignacian and Solutrian ages of man, the Chellean and Acheulean being placed in the preceding interglacial phase and the earliest of our forerunners at present acknowledged (the Reutelian) being regarded as contemporaries of the glaciers of the Lebanon.

The tabulation is undoubtedly a neat one, but it does not seem clear how Dr. Blanckenhorn explains the separation of the Dead Sea (and the greater part of the Jordan valley) from the Gulf of Akabah. The watershed between these is about 700 feet above the latter and is suggestive of movements transverse to the Jordan-Akabah trough. It is also singular that the period of greatest cold in Palestine—that of the Lebanon moraines—should correspond with the Mindel glaciation of the Alps, and that both the times of heaviest precipitation should be contemporaneous with the two smaller advances of the Alpine ice and not with the two greater, the Riss and the Würm. It is, of course, possible that the zone of heaviest precipitation did not shift southward with that of lowest temperature, but some explanation, we think, might have been offered of this rather obvious anomaly.

Perhaps also scepticism may be still permitted as to some of the subdivisions in the relics of primitive man, and even the identification of the earliest among them, but this we know is thorny ground.

The book, we think, would have been improved if the author, instead of retaining the form of a diary, had been content to give his itinerary in the fewest possible words and to group together his results so as to give continuous accounts of the stratigraphy and of his views about the physical geology, with the reasons for them. The reader at present loses his way in the mixed multitude of personal and scientific details, and perhaps sometimes fails duly to appreciate the latter. The illustrations also leave something to be desired, the sketches of sections generally being very rough. Still, Dr. Blanckenhorn has spared no pains in collecting a great quantity of information on the geology of Palestine, besides giving lists of the fauna and flora of the country, so that his book will be a very valuable addition to our knowledge of that interesting region.

T. G. B.

THE MEDICAL NEW YEAR.

ON October 1, our medical schools begin their winter session; and in many of the chief medical schools this New Year's Day is observed by giving a ceremonial address to students and others. This good custom shows some signs of old age. The need is less than it was that medical students should be warned against idleness, off-hand manners, or unkindness. The introductory address tends to have an old-fashioned air; and, it may be, the time is coming for some kind of ceremony more in accord with our present ways. The like embarrassment seems to attend the annual orations in praise of Harvey and of Hunter at the Royal Colleges of Physicians and Surgeons of England. Harvey and Hunter, we begin to think, would be glad to know that their immortal names were given a rest, in favour of the praises of some of their successors.

Still, one would be sorry that the First of October addresses should be abandoned at our medical schools. The reports of some of them, published last week in *The Lancet* and *The British Medical Journal*, are of notable interest, and cover a wide range of thought.

At St. George's Hospital, Mr. Grimsdale spoke on the present duty of the medical citizen; and the very phrase "the medical citizen" tells how far we have come from the old professional individualism of the doctor. Imagine the feelings of the physicians of King George III. if they had been told they were medical citizens. Still, there was no National Insurance Act in those not very spacious times; and Mr. Grimsdale was mostly concerned with the National Insurance Act. He put clearly and well the reasons why the doctors cannot and will not work under the Act as it stands at present; and the doctors will be glad that he reminded them of that delightful fable of the elephant and the partridge's nest.

At the Middlesex Hospital, Dr. Lazarus-Barlow chose a very different theme—the genius of the infinitely little. Why genius? Whatever attributes we may be able to assign in our imagination to the infinitely little, genius is not one of them. He ought to have said the kingdom, or the work, of the infinitely little. But he gave an admirable address. It was Pasteur, of course, of whom it was said that he had discovered the kingdom of the infinitely little. But, as Dr. Lazarus-Barlow told his audience, beyond the kingdom of the bacteria there is the kingdom of the radium emanations, which are infinitely littler; and beyond the kingdom of the radium emanations there is the kingdom of the enzymes, which are infinitely littlest. Not thought, but wonder alone, is possible in the presence of the facts of these kingdoms. It takes a very metaphysical mind to be near them.

With a sort of shock we come to Dr. Jane Walker's address to the London School of Medicine for Women. Her theme was common sense. It is a fertile subject for a medical address, and she treated it with delightful simplicity and directness. She began with those two prophets without honour in their own country, MacCormac of Belfast, and Boddington of Sutton Coldfield, who advocated the open-air treatment of consumption when as yet there was no clear understanding as to the cause and the nature of that disease. Next she praised, for the splendour of their common sense, St. Francis, Ambroise Paré, and Dr. Johnson. We think that St. Francis would rather be excused; and Dr. Johnson, like the doctors in the line "Who shall decide where doctors disagree?" was not a medical doctor; but Ambroise Paré is all right; his common sense is magnificent and unfailing. Dr. Walker gave many other pleasant and memorable examples of the sovereignty of common sense in the wisdom of life. It may be permitted to quote one out of many.

> Take the case of the "mentally defective" problem. Are we not just a little lacking in common sense in our dealing with that? Surely our attention ought to be more earnestly directed to the so-called normal people, that they do not tempt their feebler brothers and sisters, who, left alone, would do them little harm. When one reads the flood of literature that is constantly being poured out about the "menace of the feeble-minded," one is tempted to feel that a good deal of it is mere nonsense.

Indeed, we hope that all the women students who heard Dr. Walker's lecture will follow her good advice; and it is a good thing for our lady doctors in this country that they have this keen eye for the importance of common sense in medical and surgical practice.

Dr. Humphrey Rolleston's address at Manchester University is perhaps the best of all in regard to thoroughness and careful weighing of his words. He took for his subject "Universities and Medical Education." As a Cambridge man, who is likewise an examiner in Manchester University, he was able to speak with authority of the complex and ever-shifting relations between all that is called Literæ Humaniores, the medical sciences, and medical and surgical practice. It would be hard to beat his ideal of the first years of medical education.

> The education best suited for a medical student before beginning his professional subjects should be on the following lines. The subjects ordinarily taught in schools, including Latin and Greek, should be pursued until the age of about 15½ years, when the student's proficiency should be tested by an examination, the results of which should count at the university matriculation. After passing this examination the student should spend the next 2—2½ years in obtaining a sound knowledge of French and German, literature, English composition, physics, and chemistry, and the necessary mathematics. At the end of this time, when he is from 17½ to 18 years of age, he should be able to pass an examination on these subjects, and then begin the study of biology and of anatomy and physiology. This compromise would ensure general culture with a modicum of classical training, and a knowledge of French and German at a time when it can be readily acquired, and yet would not encroach unduly on the time necessary for strictly professional instruction. This education, which is somewhat on the lines provided on the modern side, would be far better than that given on the classical side at public schools, and by providing a good basis of physics and chemistry would do much to remedy the prevailing difficulty of the early science examinations in the medical curriculum.

While introductory addresses remain as good as these four, it would certainly be a pity to desert this way of observing the opening of our medical schools.

THE CHURCH CONGRESS AT MIDDLESBROUGH.

DURING the week ending on Saturday, October 5, the Church Congress has been holding its annual gathering at Middlesbrough, the great industrial centre of population which has grown up at the mouth of the Tees. The choice of such a meeting-place is at once a declaration and a challenge a declaration that the Church considers the problems of industrialism to be also the problems of religion, and a challenge to those people who would solve the riddles of capital and labour without reference to a spiritual basis for the aspirations of both parties in the conflict. It is well that any body of men and women joined together to discuss the outstanding difficulties of a common faith should feel able at times to dispense with the inspiration of mediæval architecture and academic hall and should go forth boldly to conduct their deliberations on the edge of a populous and rapidly depleting coal-field, illuminated with the glare of titanic blast furnaces.

On the whole, the choice of subjects and their treatment by the selected speakers has justified the action of the organising committee. We do not look to such meetings to produce any contribution to knowledge, but rather to express an attitude of mind and to set an example of a right method of approach to the vexed questions of the day. The eminently sane and statesmanlike influence of the Archbishop of York was felt throughout the proceedings, and his opening address contained an excellent summary of the ground to be traversed in these meetings of the Congress, and indicated the point of view from which he desired that it might be surveyed.

The papers and discussions on town planning and rural housing showed signs of a healthy realisation of the economic aspects of that question. Cottages never will and never ought to be built in any number and let at rents less than their true economic value. Such a course of action, from whatever motives it be adopted, leads in the end to a depreciation of wages. It is, in fact, a return by a circuitous route to the old and evil plan of a subsidy to wages through a widespread extension of a method of outdoor relief—a system which, under the old ante-1834 Poor Law, proved to be pauperisation in one of the worst forms. Only when it is realised that, as Mr. Raymond Unwin declared was already the case, it pays to provide good housing accommodation and that garden villages are a better form of investment than potential slums shall we see the end of the long series of lamentable mistakes in housing, some of which have recently been perpetrated afresh in connection with the opening up of the new industrial areas at Doncaster and Dover.

The question of the falling birth-rate, a fall which is very marked in the manufacturing cities of the northern provinces, wherever women are employed in factories, was dealt with by Mr. W. C. D. Whetham, F.R.S., who again emphasised the frequent opposition in present circumstances between the economic and the religious aspect of normal family life. The Church of England, unlike the Church of Rome, has not yet grasped the fact that the number and quality of her future members, indeed, her very corporate existence, can be made the plaything of social, industrial, and moral forces with which she has neglected to concern herself.

From the academic point of view, the most interesting morning was that devoted, on Thursday, to a discussion of the relation of miracles to the Christian faith, a contribution towards the agelong effort to reconcile intuitive belief and intellectual reason and to assign to each their true importance in the religious life. The subject was opened by the Dean of Christ Church (Dr. Strong) with an admirable attempt to determine how far, in the light of all knowledge at present available, it was practicable to answer the question: "Are miracles possible at all?" The Dean gave an excellent account of modern thought relating to the purely mechanical theory of life, which would regard the world as a closed system, controlled by unerring laws of matter and motion, and in which the appearance of a miracle could only be explained as the result of imperfect observation or incorrect deduction. But he pointed out that recent tendencies, both in philosophy and biology, would seem to lead away from and not towards the acceptance of such a mechanical view of nature as the complete and ultimate solution of the whole problem of existence and consciousness.

Prebendary Webb-Peploe's contribution, which was much applauded, served to remind us that for those people who are prepared to adopt intact into their theological belief the experiences attributed to Job, Daniel and Jonah, the efforts of learned professors and others to alleviate their lot are both officious and ill-judged. The discussion was closed by the Archbishop, who referred to some of the papers read at the recent meeting of the British Association for the Advancement of Science, held at Dundee, and concurred with the Dean that at the present moment it was the mechanical theory of the universe, quite as much as the miraculous basis of Christianity, that was on its trial in the world of thought. His Grace's closing sentences, as reported in *The Times,* may perhaps be given to sum up the general trend of the whole discussion. "The real meaning of the miraculous was that it was an assurance given to them that, ultimately, the Divine Being was free and master in His own house; and it was the coming forth of that fact into the world that carried with it the consequences that they called miracles."

NOTES.

THE meeting to be held at the Mansion House on October 23, in connection with the proposed memorial to the late Lord Lister, is the outcome of a movement which was set on foot by the presidents of the Royal Society and the Royal College of Surgeons. A large and influential committee has been formed, representative of scientific, medical, and general interests, both in this country and abroad, and the various possible schemes, including a memorial in Westminster Abbey, and others of an international character, will be laid before the meeting, which it is hoped will be largely attended.

THE Royal Microscopical Society has arranged to hold a conversazione at King's College, London, on Wednesday, October 16, from 8 to 11 p.m.

THE extension to the Manchester Museum will be opened on the afternoon of Wednesday, October 30, by Mr. Jesse Haworth. An address will be delivered by Prof. W. M. Flinders, F.R.S.

MR. E. GRANT HOOPER, superintending chemist, Government Laboratory, and vice-president of the Society of Chemical Industry, has been appointed Deputy-Government Chemist, in succession to Mr. H. W. Davis, who has retired.

SIR GEORGE DARWIN, K.C.B., F.R.S., Plumian professor of astronomy at Cambridge, who, we regret to learn, has been ill for two or three weeks, underwent a severe operation on Thursday last. On Sunday he spent a bad night, but we are glad to be able to state that he is now making good progress.

The Home Secretary has appointed a committee to inquire and report as to the precautions necessary in the use of celluloid in manufacture and the handling and storage of celluloid and celluloid articles. The members of the committee are:—The Earl of Plymouth (chairman); Prof. J. J. Dobbie, F.R.S., principal Government chemist; Captain M. B. Lloyd; Mr. H. M. Robinson, Deputy Chief Inspector of Factories; and Mr. E. O. Sachs, chairman of the executive of the British Fire Prevention Committee.

We notice with regret the announcement of the death on Sunday, October 6, at seventy-six years of age, of Prof. W. W. Skeat, professor of Anglo-Saxon in the University of Cambridge, and of world-wide distinction among philologists. In his early years he showed talent in mathematical studies, and he took his degree at Cambridge in the Mathematical Tripos, where he was placed as fourteenth Wrangler in 1858. After a few years spent in country curacies, he returned to Cambridge in 1864, and was appointed a mathematical lecturer at his own college, Christ's. He then commenced the etymological studies represented in the long series of publications upon the English language which forms an imposing monument to his knowledge and industry.

The third International Archæological Congress was opened in Rome on Wednesday, October 9. We learn from *The Morning Post* that no fewer than twenty-four Governments are officially represented, but the British Government is absent from the list, though one department—the Board of Education—is represented by Dr. Ashby, the resident director of the British School at Rome. British universities and other learned societies, however, are well represented. The congress will be divided into twelve sections, according to subjects. Among the themes to be discussed are:—The Iron age in Italy, the prehistoric civilisation of Sardinia, the monuments of Egypt and Asia, Minoan civilisation, the origins of Etruscan culture, the territories of the old Italian cities, Roman epigraphy, numismatics, the roads of the Roman Empire, and the question of archæological bibliography.

An interesting and important step towards systematised nature-protection has been taken by the Royal Society for the Protection of Birds. This is the taking over of the remarkable Somerset headland, Brean Down. For permission to establish this sanctuary the society is indebted to the wisdom of the Somerset County Council, the action of which may well form a precedent for county councils throughout the kingdom. The society has the "shooting rights," and has appointed a watcher, but the general maintenance of the place will depend largely on the support given to the society. Subscriptions for this or other work of the society may be sent to the secretary, 25 Queen Anne's Gate, S.W. The joint action of local governing bodies, of protection societies, and of private individuals is the kind of method that should succeed in this country. "Our Dumb Friends' League" will hold a meeting at the Whitehall Rooms on October 15, at which Mr. James Buckland, the promoter of the Plumage Bill, Colonel Sir Mark Lockwood, M.P., and Mr. George Greenwood, M.P., will speak. The Ranee of Sarawak will preside. Brean Down is a bare grassy promontory with broken cliffs. It is well known to botanists as a habitat of the white rock rose. Its chief bird—there are three specially protected—is the beautiful sheldrake. Of the other two, the raven has built here for fifty years. Lately the peregrine, so often found near the raven, has established itself. Mr. Harry Cox, to whose zeal the new sanctuary mainly owes its institution, last year rescued the only young one. Kingfishers, sparrow-hawks, daws, kestrels, shrikes, linnets, rock-pipits, and wheat-ears are also natives.

Three important plaster casts have been added to the exhibition of fossil reptiles in the department of geology in the British Museum (Natural History). A copy of the skull of the gigantic carnivorous dinosaur, *Tyrannosaurus rex*, is interesting for comparison with the fragmentary remains of Megalosauria found in England. The original specimen was obtained by the American Museum of Natural History from the Upper Cretaceous (Laramie Formation) of Montana, U.S.A., and as it measures no less than 4 ft. in length, the carnivore to which it belonged would be able to prey on the contemporaneous herbivorous dinosaurs, Trachodon and Triceratops. A copy of the skeleton of a pterodactyl, with large slender teeth, lately discovered by Mr. B. Hauff in the Upper Lias of Würtemberg, shows again how completely developed were the flying reptiles even in the early part of the Jurassic period. A cast of a nearly complete skeleton of the Permian labyrinthodont, *Archegosaurus decheni*, in the museum of the Prussian Geological Survey at Berlin, is a useful acquisition in view of the researches now in progress concerning the origin of reptiles and their connection with amphibians.

By the tragic death of George Herbert Grosvenor, who was drowned at Polzeath on September 4, whilst endeavouring to save the life of a friend, biology has lost one of the most promising of her younger workers. After a brilliant career at Harrow, Mr. Grosvenor was elected to a biological exhibition at New College, Oxford, subsequently taking a first in his Final School. Elected to the Oxford table at Naples, he confirmed, by a brilliant piece of work, Strethill Wright's almost forgotten suggestion that the nematocysts of Æolids were derived from their prey. His work was awarded the Rolleston prize in 1904. On his return to Oxford he became busily engaged in founding a new school of economic entomology, and with his characteristic thoroughness had acquired a wide knowledge of insects. His regular work left him but little time for research, though it is hoped that the results of some of his investigations may yet be published. Of his great personal charm this is not the place to speak. He combined an exceptional power of concentration and clearness of thought with a singularly modest and retiring disposition, and his loss will be long and deeply felt by those whose good fortune it was to be his associates.

The statue of Captain James Cook presented to the town of Whitby by the Hon. Gervase Beckett, M.P., which was unveiled on October 2, will be welcomed as a fitting memorial to a man who succeeded, where many others had failed, in laying open the secrets of the Pacific Ocean, thanks mainly to inborn determination and courage. Cook was not a man of many or varied attainments. He was born of lowly parents, and from his earliest years his whole energy was directed towards perfecting himself in the work of his calling on the sea. The same energy and stedfastness of purpose, joined to his temperance and his mastery of every detail of his profession, enabled him to carry through the journeys which elucidated the questions as to the amount and extent of the lands in the Southern Ocean, the answer to which had eluded so many less competent and persevering explorers. It is on his work as a voyager and discoverer that Cook's chief claim to fame is based, but the fact that he was the first to take scientific preventive measures against scurvy, the disease which has wrecked the hopes of so many explorers, earned him the gratitude of voyagers. It was for his splendid work in this direction that he was unanimously elected a fellow of the Royal Society after his return from his second voyage in 1775. On this he had kept the sea for three years, and but one of his crew of 118 men was lost.

In the report of the Rhodesia Museum—which is now under the joint control of the Bulawayo municipality and the Rhodesia Scientific Association—for 1911, it is stated that the building opened by H.R.H. the Duke of Connaught in 1910 is already well-nigh filled, and that proposals for enlargement are already under consideration. There is the usual complaint as to the insufficiency of funds, even for ordinary purposes.

The hundredth volume of the *Zeitschrift fur wissenschaftliche Zoologie* was completed with the part published on June 25 last, and already three parts of the hundred and first volume have appeared since that date. The degree of elaboration to which it is possible to bring the study of invertebrate anatomy is well illustrated in recent volumes of this valuable series. The last part issued (vol. ci., part 3) contains the first continuation of the fifth part of Dr. Friedrich Voss's memoir on the thorax of the domestic cricket, and this continuation alone contains no fewer than 134 pages. Truly the accumulation of detailed information with regard to the animal kingdom goes on at a great rate, especially in Germany.

Canada, it appears from the report of the Commissioner of Dominion Parks for 1911, published by the Government Printing Bureau at Ottawa, now possesses seven public parks in which native animals are preserved. Some of these, which contain hotels and medicinal baths, are to a great extent self-supporting, and all are stated to be making rapid and satisfactory progress. In the Rocky Mountain Park at Banff, where the use of firearms, save in exceptional circumstances, is prohibited, the animals are becoming increasingly tame, deer visiting the lawns of the residences, and bighorn sheep wintering within half a mile of the Pacific Railway. The bison (buffalo) in the Buffalo Park at Wainwright are in a thriving condition, and promise a large natural increase in the future.

The last report of the Madras Museum records steady progress in the arrangement of this important collection and in the acquisition of new specimens. The great series of bronze images has been re-classified, and a considerable number of fresh copper plates has been added. The numismatic department has received large additions in the shape of pagodas, fanams, and six Venetian sequins. Among the accessions to the natural history collections may be mentioned the first Indian specimen of Swinhoe's snipe (*Gallinago megala*), shot recently in the Chingleput district, a bird which breeds in Eastern Siberia and Northern China, and migrates in the cold season to Southern China and the Malay Peninsula, the few existing specimens having been procured from the Malay Peninsula, Burma, and Assam.

In the August number of *The National Geographic Magazine*, Mr. Carl E. Akeley narrates, with a great wealth of photographic illustration, his experiences during an expedition to East Africa for the purpose of obtaining a series of elephants to form a group in the American Museum of Natural History. The main note of the article is the growing scarcity of old bulls with tusks of more than 50 lb. in weight. The best specimen obtained was a young bull standing 11 ft. 3 in. at the shoulder, with tusks weighing respectively 100 and 102 lb. These tusks were comparatively young ivory, and it is estimated that if the animal had been suffered to live another fifty years it would have developed tusks of something like 200 lb. weight, such tusks being by no means abnormal, but merely the ordinary development of mature bulls of the Uganda race. When, however, a bull grows tusks of 50 lb. weight, which he does in about twenty-five years, he becomes the target of every hunter in the country, and it is consequently only a few individuals, which obtain protection by living amid large herds of cows or in dense forests, that can attain full maturity. Large tusks must therefore become very rare in the near future. Attention is also directed to the damage to forests and cultivation due to herds of elephants from which tuskers have been killed off, damage which may lead to reprisals from proprietors as the country becomes opened up.

The forty-third annual report of the American Museum of Natural History for the year 1911 begins by recording that the trustees have resolved to complete the building of the southern half of the museum in time for the celebration of the jubilee in 1919. Special halls will thus be provided for whales, fishes, oceanography, and geography, while numerous rearrangements for the more adequate display of the collections will be possible. With characteristic energy, and with the aid of private benefactions, the museum employed no fewer than forty-four parties for the collection of specimens in various parts of the world. It is, therefore, making haste to rival in opportunities for natural history research the older foundations, the growth of which has been more gradual. Among notable accessions thus obtained during 1911 may be mentioned mammals and birds from Lower California and the northern part of South America, invertebrates from the West Indies and British Guiana, fossil mammalian remains from Cuba, and a glacial pot-hole from St. Lawrence County, New York. The Williston collection of tropical Diptera was also purchased. Among new exhibits illustrated in the report, the group of skeletons of extinct ground-sloths from South America is especially important, while a set of restored models of Devonian fishes arranged in the form of an aquarium is at least striking. Probably on account of the intimate association of the museum with elementary education, most of the exhibits seem to be more pictorial in character than those to which we are accustomed in European museums. The American museum is to be congratulated on being able at the same time to occupy a foremost place in the advancement of knowledge by its valuable publications.

Mr. L. L. Woodruff (Proc. Soc. Experimental Biology and Medicine, vol. ix., p. 121) has now continued his pedigreed culture of the common ciliate infusorian, *Paramoecium aurelia*, for five years. The culture was started in May, 1907, with a wild individual isolated from a laboratory aquarium. From the progeny of this specimen individuals have been isolated practically daily, and cultivated in sterilised infusions of hay and other vegetable substances. During the five years to May, 1912, 3029 generations have been produced without any conjugation having taken place, and the organisms are still in as normal condition, both morphologically and physiologically, as the original wild ancestor. The author concludes that the original individual cell possessed the potentiality of producing descendants the number of which is represented by at least 2 raised to the 3029th power, and that senescence and the need of fertilisation are not primary attributes of living matter.

In No. 6 of the Kew Bulletin, Mr. W. J. Bean gives an extremely interesting account of various gardens and parks in South Europe, including the famous garden at La Mortola, the acclimatisation garden at Hyères, the Villa Thuret and Eilen Roc gardens at Cap d'Antibes, and the fine gardens at Milan, Pallanza, Florence, Naples, Bologna, Padua, and various towns on the Adriatic coast. These notes, based on a tour made by the author in early summer of this year, should prove most useful to botanists who may wish to visit Italy and the adjacent parts of South Europe. The same number contains descriptions and plates of two recent additions to the Kew collection—a spurge (*Euphorbia meloformis*) and a cycad (*Cycas Micholitzii*). The former is one of the most remarkable South African spurges, and bears such a striking resemblance to *Echinocactus* that a non-botanist would never suppose that they belonged to two totally different families of plants.

Dr. R. R. Gates, who has contributed so much to the recent literature of mutation by his cytological work on Œnothera, describes in *The New Phytologist* (vol. xi., No. 2) a peculiar development which occurred in his cultures of evening primroses obtained originally from the Lancashire coast. In some of the forms the stem internodes remained undeveloped, though growth continued and new cycles of rosette leaves were continually added above while the older ones died away below. In this way a stem was produced which was covered with leaf-bases and bore a crown of leaves at the top, giving a striking resemblance to a cycad. From these and other forms it is hoped by further work to learn something more regarding the manner of origin of the various Œnotheras, and in particular to analyse the De Vriesian factor of evolution and ascertain in how far it is merely a process of hybrid-splitting and in how far it is a more deep-seated germinal disturbance—resulting in part from effects of previous crossing, from the direct influence of changed environment, or from some internal and unknown cause.

Mr. Neil E. Stevens has sent us a reprint of his recent paper (*Botanical Gazette*, April, 1912) on the cytology of heterostyled plants, containing observations on buckwheat and *Houstonia coerulea*. Zoologists have shown that in various insects the sperms are of two kinds, equal in number, and differing in respect of one or more of their chromosomes, and it has been shown that fertilisation of the eggs by one kind of sperm produces males, by the other kind females. This remarkable discovery has suggested the possibility of a similar condition in other organisms having separate sexes, but so far no evidence of such a "sex determinant" has been obtained in diœcious plants. In buckwheat, Stevens finds that in the mitosis of the pollen mother-cells the chromosomes of the short-styled form are much larger than in the long-styled form, also that there is a characteristic and constant difference in the arrangement of the chromosomes at one stage (anaphase) of the reducing nuclear division. In *Houstonia coerulea* the difference in size of the chromosomes is less marked, and there is apparently no difference in arrangement.

In our issue of July 25 we referred to a useful series of wind charts relating to the monsoon area of the North Indian Ocean, published by the U.S. Weather Bureau. This has been supplemented in its meteorological chart of the Indian Ocean for October by an interesting discussion, "Weather of India and her Seas," by the same writer (Mr. W. E. Hurd). He points out the close connection between the meteorology of India and the adjacent seas. Apart from the seasonal effects of insolation, the weather is directly associated with the distribution of atmospheric pressure in various regions, the changes in which produce the summer and winter monsoons. The writer traces the effects of these over various districts in a clear and instructive manner, some of the data being naturally drawn from the records of the Indian Meteorological Department. In the October charts of the North Atlantic and North Pacific oceans the Weather Bureau directs attention to recent alterations in the Act regulating wireless telegraphy, one provision of which enacts that no vessel licensed to carry fifty or more persons shall leave the shores of the United States from October 1 unless equipped with efficient apparatus for radio-communication, to be used during day and night, and capable of transmitting and receiving messages over a distance of at least one hundred miles.

In "Relative Bestimmungen der Intensität der Schwerkraft" (Karlsruhe: G. Braun), Dr. E. Becker gives the results of a series of pendulum experiments conducted during the years 1900–05 in Alsace-Lorraine. The work of the group of experimenters concerned appears to have been very carefully performed and the reductions of the observations have been carried out with a due recognition of the systematic errors likely to be present. Using Helmert's system of corrections to sea-level and giving to the ideal surface layer of land a density of 2·4, the experimenters find the western Rhine valley to be a region where gravity has its normal value. In general the higher land to the west is a region of gravity-excess. The map which accompanies the work would enable the reader to make a more intelligent use of the tabulated results if by shading or otherwise it gave an idea of the level contours or of the geological distribution. That would at once confirm or disprove the idea left by the table that no marked correlation between gravity-variation and height or geological conditions has been found. Another useful addition to the work would have been some illustrations of the apparatus used and described. It is to be hoped that the experiments will be extended as suggested in the last sentence of the memoir.

The volume of Contributions from the Jefferson Physical Laboratory of Harvard University for the year 1911 extends to nearly 400 pages, and contains eight memoirs, several of which we have already noticed in these columns. More than half the present volume is occupied by the important papers of Bridgeman on the properties of water and of mercury at pressures up to 20,000 kilogrammes per square centimetre, and at temperatures between $-80°$ and $+80°$ C. In addition to the new information these papers supply as to the various modifications of ice and the conditions of equilibrium amongst them, they show that the laws of change of state from solid to liquid are much simpler than the theories and observations of Tammann and of van Laar have led us to believe. Each melting point, for instance, changes with pressure in the same direction at these great pressures as it does at lower pressures, so that there is no maximum melting point in the case of mercury or minimum in the case of water. It seems probable that the maxima observed by Damien were due to slight impurities, too small to have observable effects on the melting points at low pressures, but which appear to have considerable effects at these high pressures.

A copy has been received of the third edition of "The Record of the Royal Society of London," prepared in connection with the celebration of the 250th anniversary of the foundation of the society. The volume, which may be obtained of Mr. Henry Frowde, Amen Corner, E.C., price 15*s*. net, is much larger and more complete than previous editions, and is a valuable official statement of the development and position of our leading society for the promotion of natural knowlege. The chapter of greatest general interest is that with which the volume opens, on the foundation and early history of the society. This has been re-written by the president, Sir Archibald Geikie, who has also supervised and edited the whole work. The three charters are printed in full, with translations, while other chapters are devoted to the statutes, trusts, benefactions, medallists, committees, and like matters. There is a chronological register of fellows, as well as an alphabetical list, with dates of election. The volume is illustrated by twenty excellent plates, mostly from portraits of former fellows in the society's possession. Among the additions to the new edition are portraits of Lord Kelvin, Lord Lister, and Charles Darwin. The officers and the clerical staff have been successful in producing an attractive volume of more than domestic interest.

Mr. C. Baker, 244 High Holborn, has just issued a new classified list of second-hand instruments for sale or hire. The catalogue contains particulars and prices of more than fifteen hundred optical and other instruments and accessories offered at low prices. Every instrument is guaranteed to be in adjustment, having been put in order where necessary in Mr. Baker's workshops or in the works of the original makers.

Fifty volumes of the "Cambridge Manuals of Science and Literature" have now been published by the Cambridge University Press. Among the most recent additions may be mentioned "The Work of Rain and Rivers," by Prof. T. G. Bonney, F.R.S.; "Brewing," by Mr. A. Chaston Chapman; "The Individual in the Animal Kingdom," by Mr. Julian S. Huxley; "House-flies and How they Spread Disease," by Dr. C. G. Hewitt; and "The Psychology of Insanity," by Dr. Bernard Hart. We notice, too, that Mr. L. Doncaster's volume in the series, "Heredity in the Light of Recent Research," has reached a second edition, in which a chapter on heredity and sex has been added.

OUR ASTRONOMICAL COLUMN.

Gale's Comet, 1912*a*.—No. 4602 of the *Astronomische Nachrichten* contains new elements for comet 1912. A set by Mr. H. E. Wood puts the perihelion passage back to October 1·86, and reduces the inclination of the orbit to 51° 54′; another by Mr. Merfield agrees fairly well with that published by Dr. Ebell, who gives a new ephemeris, derived from corrected elements, from which the following is taken:—

Ephemeris, 12h. M.T. Berlin.

1912	α (true) h. m.	δ (true) ° ′	log r	log Δ	Mag.
Oct. 13	15 43·4	+8 27·1	9·8673	0·0454	6·3
15	15 46·2	+10 28·3			
17	15 48·7	+12 23·9	9·8806	0·0588	6·4

It will be observed that this ephemeris gives the declination for October 13 nearly 1° more northerly than that we gave, from the earlier ephemeris, last week; the calculated magnitude is also considerably fainter. An observation by M. Gonnessiat at Algiers on September 26 gave the magnitude as 8·0.

SUN-SPOT ACTIVITY.—There has recently been some slight suggestion of a recrudescence of sun-spot activity, although one scarcely expects the actual minimum to have passed yet.

In the earlier part of the year very few spots were seen, and those that did appear were very small and seemed to be very shallow, for they generally filled up and disappeared while the region was still on the visible hemisphere. One exception was a fairly large black circular spot, which endured from June 17 to 28, and on Saturday last there appeared a small group, containing two intense nuclei, just south of the sun's centre, on the central meridian; this is now a fair-sized group, and should be seen near the western limb about October 11 or 12.

THE SYSTEMATIC MOTIONS OF SUN-SPOTS.—Acting on a suggestion conveyed to him by the statement that "the rotation periods given by different spots in the same zone of latitude differ more widely than do the mean rotation periods for different zones of latitude," given in Mr. and Mrs. Maunder's paper on the solar rotation period, Prof. Hirayama has analysed the motions of spots given in the Greenwich, Carrington's, and Spörer's publications, and finds that apparently there are two drifts of sun-spots exhibiting distinctive systematic motions. The angular velocity of drift i. is represented by $\xi = 14{\cdot}37^\circ - 2{\cdot}97^\circ \sin^2\lambda$ (where λ = the heliographic latitude), and of drift ii. by $\xi = 14{\cdot}69^\circ - 2{\cdot}65^\circ \sin^2\lambda$; the former agrees fairly well with the mean values found by other investigators, while the latter exceeds it, showing a mean rate about $0{\cdot}35^\circ$ greater than that indicated by drift i. For the lower latitudes, the rotation period proper to drift ii. agrees fairly well with that found spectroscopically by Messrs. Storey and Wilson, and Prof. Hirayama suggests that possibly certain groups of spots, by a proper motion of their own, come to the same level as the chromospheric layer investigated spectroscopically, and attain its angular velocity. He also suggests that this idea of two drifts may explain the distribution of sun-spots with different rotation periods in any particular zone of latitude. The data considered by him show that there are about twice as many sun-spots collected in drift i. as in drift ii. (Journal of the College of Science, Imperial University, Tokio, vol. xxxii., No. 7.)

THE PARALLAX OF NOVA LACERTÆ.—In No. 52 of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo*, Herr Balanowsky discusses the attempt made at Pulkowa to determine the parallax and proper motion of Nova Lacertæ. Sixteen plates were taken between January 4, 1911, and February 19, 1912, but two had to be rejected because the images were poor. The first solution from the remaining fourteen plates gave values which were small as compared with their probable errors, but indicated that the proper motion in declination was probably zero. The final solution gave for the value of the parallax $0{\cdot}005'' \pm 0{\cdot}020''$, which practically means that it was zero, and indicated that the proper motion in right-ascension did not exceed $+0{\cdot}01$s.

THE ROYAL HUNGARIAN ASTROPHYSICAL OBSERVATORY.—In No. 14 of the *Kleinere Veröffentlichungen des Königl. Ungarischen Astrophysikalischen Observatoriums*, Dr. Konkoly gives a very detailed description of the instruments added to the equipment of the observatory between the beginning of 1908 and the end of 1911. Many of the instruments have been made for special purposes, and the book, consisting of 166 pages, fully illustrated, should prove exceedingly useful to anyone desiring to set up instruments for astrophysical researches.

OBSERVATIONS OF VARIABLE STARS.—In No. 9 (vol. i., second series) of the *Memorie della Società degli Spettroscopisti Italiana*, Signor E. Padova publishes the values and light curves determined from observations of variable stars during the years 1907–11. Eleven stars are dealt with, and these are divided into three groups, viz. Algol variables, short-period, and long-period variables. In several cases the light-curves are compared, graphically, with those drawn from published elements, or determined by other observers, and the differences between them are discussed. For Mira Ceti the observer found a minimum of magnitude 9·36 on January 15, 1912.

BIRD NOTES.

IN the August *Zoologist* Mr. Collingwood Ingram points out that four races of the furze-warbler are recognisable, namely, the typical *Sylvia undulata* of the northern Mediterranean countries, *S. u. aremoricus* of the Atlantic coast of France and Spain, the north African *S. u. toni*, and the British *S. u. dartfordiensis*, a Dartford warbler, the last being distinguished by its brown back and the smaller development of the white tips to the throat and breast feathers.

The migratory birds visiting the Buffalo River district form the subject of an article by the Rev. R. Godfrey in the June issue of the Journal of the South African Ornithologists' Union. Among the species observed were the white and black stork, the European swallow, and several kinds of cuckoos.

In the July issue of *The Emu* Dr. J. B. Cleland continues his account of the results of an examination of the contents of the crops and stomachs of Australian birds, the total number of species which have passed through his hands being 305. Farmers and gardeners should now be able to discriminate without difficulty between beneficial and harmful birds.

A hand-list of the birds of Formosa, by Mr. S. Uchida, is included in vol. iii. part i., of *Annotationes Zoologicae Japonenses*. In a list published in 1907 by Messrs. Ogilvie-Grant and La Touche, 260 Formosan species were recognised; the author has been able to raise the number to 290. The discovery of a species of Dicœum has introduced an additional family into the avifauna of the island. We notice that on page 169 *Cuculus canorus* is misprinted *Cuculus canolus*, the error being repeated on page 209 of the distributional list.

No. 23 of *Harmsworth Popular Science* contains an article on the difficulties of bird-classification, although its contents scarcely bear out the title. There are, moreover, statements which do not represent the facts, as, for instance, the assertion that the seriema was originally grouped with the secretary-bird. Again, we find it stated on page 2736 that "the boat-billed heron, . . . the whale-headed stork, . . . and the hammer-head are famous members of the heron tribe," whereas these three birds severally represent the same number of distinct families, which in the British Museum Hand-list are assigned to as many suborders.

In *British Birds* for September, Mr. H. W. Robinson states that two nests of the eider were observed on June 2, 1912, on a small island just off the coast of Ireland. Hitherto eiders have been known in Ireland only as occasional stragglers. It is a matter for regret that in each instance the eggs were taken.

In Reichenow's *Ornithologische Monatsberichte* for July and August, 1912, Mr. J. Thienemann records that a laughing gull (*Larus ridibundus*), marked at Rositten, was shot on a swamp in the West Indies in November, 1911. R. L.

EXPERIMENTAL WORK AT AN AGRICULTURAL COLLEGE.[1]

THE bulky annual before us consists of reports from the various departments of the South-Eastern Agricultural College, prefaced by editorial notes, which summarise the present position of the college. This appears to be satisfactory, and progress in several directions is being made. The editor is dissatisfied with the recognition of Long Ashton by the Development Commissioners as the chief fruit research station for England and Wales. But it must not be forgotten that Long Ashton serves the most important fruit area in the country, extending from Devonshire to Herefordshire and Worcestershire. Wye, however, is to have a research plantation for fruit and hops.

(1) *Farm and Dairying.* The chief point of interest mentioned by Mr. Mackintosh has reference to the good results obtained by spraying potatoes: "the yields from sprayed and unsprayed plots showing a balance of four tons per acre in favour of the former." The sugar-beet experiments proved, as elsewhere, that the crop can be successfully grown in this country, but it remains to be shown whether the manufacture of beet-sugar is destined to become an important British industry. Sugar-beet slices and coconut cake were found to be useful artificials.

(2) *Hops and Horticulture.* The article by Messrs. Smith and Wellington on the packing of apples is particularly interesting, especially in relation to the establishment of a commercial fruit show in Kent.

(3) *Economic Zoology.*—Prof. Theobald's report is of considerable length, and, as usual, contains a large amount of familiar matter as well as valuable additions to knowledge. The illustrative plates are excellent. The author has spent much time in investigating aphides, of which 174 species (ten hitherto undescribed) have been found in Kent. The egg-laying of the pear-midge (*Diplosis pyrivora*, Riley) is for the first time described in detail; an excellent account is given of the narcissus-flies (*Merodon equestris*, Fbr., and *Eumerus strigatus*, Fln.); and the house-fly as a carrier of disease germs is described in unsavoury detail.

(4) *Chemistry.*—The two most important articles in Prof. Auld's report have reference to the formation of prussic acid from linseed cake and other feeding stuffs, indicating a certain necessity for care in their use; and the extraction of nicotine from tobacco, with a description of experiments in denaturing.

(5) *Botany.*—Prof. Parkinson contributes an interesting note, in continuation of previous work, on the forcing of plants by warm-bath treatment, *e.g.* bulbs of hyacinth and narcissus soaked in water at a temperature of 88° F. for twelve hours rapidly outstripped untreated ones (Fig. 1). Mr. Garrad gives his second report on the growing of tobacco for nicotine extraction, and the Principal contributes a note on the smoking qualities of the tobacco, which would seem to be remarkably good.

FIG. 1. Narcissus. D—"Dipped" plants. C—Undipped or control plants. From the Journal of the South-Eastern Agricultural College.

(6) *Economic Mycology.*—Prof. Salmon's invaluable report deals with the use of lime-sulphur wash and with American gooseberry mildew; and a reprint is given of the important presidential address on "Economic Mycology and some of its Problems" which he delivered to the British Mycological Society last year. Among other things, the significance of "bridging species" is pointed out, *e.g.* the spores of grass-mildew (*Erysiphe graminis*) taken directly from *Bromus racemosus* cannot infect *B. commutatus.* They can, however, infect *B. hordeaceus*, and the spores developed in this species germinate effectively on *B. commutatus.* The methods of combating fungoid disease are also discussed in a luminous fashion.

(7) *Notes on Hops.*—Prof. Salmon describes in detail the work done by way of raising new varieties of hops, and the sending out of male hops to growers.

(8) *Veterinary Science.*—Prof. Cave decides against preventive treatment, on the lines so far devised, in the case of "struck sheep," and gives an account of Jöhne's disease; while Mr. Bruce Gardener communicates the results of his useful research on parasitic gastritis in sheep and cattle ("Lincolnshire lamb disease"), due to species of the nematode genera Hæmonchus, Ostertagia, and Trichostrongylus. As these pests are common to sheep and horned stock, it is clear that the common practice of turning cattle on to pasture dangerous for sheep should not be pursued, though horses and pigs will take no harm.

J. R. AINSWORTH-DAVIS.

[1] The Journal of the South Eastern Agricultural College, Wye, Kent, No. 20 for 1911. Pp. 510. (London and Ashford: Headley Bros.) Price 7s. 6d., post free.

ADDITIONAL FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

Williams and Norgate.—Soil Fertility and Fertilisers, J. E. Halligan, illustrated.

ANTHROPOLOGY.

Chapman and Hall, Ltd.—The Aborigines of South America, Col. G. E. Church. *G. G. Harrap and Co.*—Cave, Mound, and Lake Dwellers, and other Primitive People, F. Holbrook, illustrated. *Hodder and Stoughton.*—The Individual Family of the Australian Aborigines, B. Malinovski. *Williams and Norgate.*—The Lost Language of Symbolism: an Inquiry into the Origin of Certain Letters, Words, Names, Fairy Tales, Folklore, and Mythologies, H. Bayley, 2 vols.

Biology.

G. Allen and Co., Ltd.—The Sheep and its Cousins, R. Lydekker, illustrated. *H. Frowde and Hodder and Stoughton.*—Curiosities of Natural History, F. Buckland; Wonders of the Shore, F. M. Duncan; The Lobster and his Relations, F. M. Duncan; The Starfish and his Relations, F.M. Duncan; Dwellers in the Rock Pools, F. M. Duncan; Life in the Deep Sea, F. M. Duncan; The Sea Birds, F. M. Duncan. *G. G. Harrap and Co.*—Lessons from Nature's Workshop, W. J. Claxton, illustrated. *Hutchinson and Co.*—Messmates: a Book of Strange Companionships, E. Step, illustrated; The Infancy of Animals, W. P. Pycraft, illustrated; Toadstools and Mushrooms of the Countryside, E. Step, illustrated; British Freshwater Fishes, Sir H. Maxwell, Bart., illustrated. *Sampson Low and Co., Ltd.*—Sketches of Country Life and other Papers, E. Step, new edition, illustrated. *J. Nisbet and Co., Ltd.*—Exercises in Nature Study, 3 books. *Williams and Norgate.*—Nervation of Plants, F. G. Heath; A Naturalist in Oceania, A. S. Meek, edited by F. Fox, illustrated.

Chemistry.

J. and A. Churchill.—Fatty Foods: their Practical Examination, E. R. Bolton and C. Revis, illustrated; The Preparation of Organic Compounds, E. de Barry Barnett, illustrated. *J. B. Lippincott Co.*—Industrial Organic Chemistry, S. P. Sadtler, new edition, illustrated.

Engineering.

D. Appleton and Co.—Gas Engine Principles, R. B. Whitman, illustrated.

Geography and Travel.

Sampson Low and Co., Ltd.—Round the World for Gold, H. W. L. Way, illustrated. *G. Philip and Son, Ltd.*—Livingstone and the Exploration of Central Africa, Sir H. H. Johnston, new edition; Philips' Geo-graph Book, J. H. Hack; Philips' Contour Exercise Book for Working Out Geographical Problems, E. Young and J. Fairgrieve; Philips' Visual Contour Atlas, edited by G. Philip.

Geology.

G. Allen and Co., Ltd.—The Petrology of Sedimentary Rocks, Dr. F. H. Hatch and R. H. Rastall, illustrated. *G. G. Harrap.*—A First Course in Physiography, A. L. Arey and others, illustrated. *Williams and Norgate.* The Mineral Kingdom, Prof. R. Brauns, translated by C. J. Spencer, illustrated.

Mathematical and Physical Science.

Hutchinson and Co.—Astronomy, G. F. Chambers, illustrated. *Sampson Low and Co., Ltd.*—A Treatise on Photographic Optics, R. S. Cole, new edition, illustrated. *Rivingtons.* — Introductory Physical Measurements, A. W. Mason.

Medical Science.

G. Allen and Co., Ltd.—The Student's Human Physiology, E. Evans. *J. B. Lippincott Co.*—A Treatise on Commercial Pharmacy, D. C. O'Connor, illustrated; Manual of Human Embryology, edited by F. Keibel and F. P. Mall, 2 vols., illustrated. *J. MacLehose and Sons (Glasgow).*—Immunity: a Manual for Practitioners and Students of Medicine, E. T. Fraser. *J. Nisbet and Co., Ltd.*—Auto-Innoculation in Pulmonary Tuberculosis, M. Paterson, illustrated; Tuberculin in the Diagnosis and Treatment of Tuberculosis, W. C. Wilkinson; the Tuberculin Treatment of Consumption, H. V. Barber. *Stanley Paul and Co.*—The Physiology of Faith and Fear: or the Mind in Health and Disease, W. S. Sadler, illustrated.

Technology.

Chapman and Hall, Ltd.—Metalwork and Enamelling, H. Maryon, illustrated.

Miscellaneous.

G. Allen and Co., Ltd.—A History of Psychology, Dr. G. S. Brett; Experimental Psychology and Pedagogy, Dr. R. Schultze, translated by R. Pintner, illustrated. *D. Appleton and Co.*—Sociology in its Psychological Aspects, C. A. Elwood. *Hodder and Stoughton.*—Petroleum: the Motive Power of the Future, W. S. Tower and J. Roberts, illustrated. *Sampson Low and Co., Ltd.*—Outlines of Moral Philosophy, Prof. D. Stewart, with a Memoir, &c., by Prof. J. M'Cosh, new edition.

THE BRITISH ASSOCIATION AT DUNDEE.

SECTION K.

BOTANY.

Opening Address by Prof. Frederick Keeble, Sc.D., President of the Section.

It is with more than the normal trepidation natural to presidents that I, who have worked on the borderlines of several biological sciences, undertake the task of addressing the members of this section. As well might a rogue and snapper-up of unconsidered trifles recite his doggerel songs before a bench of learned magistrates.

Therefore, although I have studied from their works the ways of presidents, and although I shall strive to keep the path which they have mostly trod, yet should I stray I plead with Autolycus that—

"When I wander here and there,
I then do most go right."

The addresses which I have consulted show me two alternative models.

I may take all knowledge for my province and discourse on the progress of our science as a whole. This is Ercles's vein, a tyrant's vein. Or as a lover of a department of the science and more condoling, I may confine my address to a special branch of botany. Each method has its merits and its drawbacks, and the one is corrective of the other.

The departmental method depicts the tree of knowledge in sympodial symmetry. The branch which the president of one year holds out for our inspection is seen arising from an erstwhile dormant lateral bud far back from the growing point of the branch exhibited by his predecessor. Under the magic of the presidential hands the new branch grows as grows the enchanted mango. Like the lean kine, it eats up the fat kine, and by the end of the address it dominates all other branches.

The general method shows the tree in other guise. As an artist is wont to paint a tree, so the historian draws it on monopodial lines, with branches standing in due subservience to the leader and in strict coordination with one another. Together these methods tell the truth, which is that the tree of knowledge grows, like many another broad-leaved tree, by a mixed process of monopodial sequences following upon sympodial developments.

What is to the specialist, and indeed for a space is, the luxuriant predominance of his branch appears in historical perspective but as a new lateral for the extension of all the sublateral shoots of science.

Such a new basis for the further growth of all the branches of botany is provided by the lusty shoot of Mendelism, and after weighing the alternatives, and with the reserves announced already, I propose to try to show that this recent outgrowth of the tree of knowledge is destined not to mar its symmetry, but to aid the growth of the whole crown. This, my chief task, should have been my first care had not an event occurred since the last meeting of this Association which compels me, in common with all botanists, to divert thought from its preoccupation and to look back along the route which our science has travelled during the last few decades.

That event, I need not say, is the death of Sir Joseph Hooker, a former president of this Association and twice president of this section. The most venerable and distinguished of British botanists, Sir Joseph Hooker was well-nigh the last survivor of that band of Victorian naturalists who helped to lay the foundations of biology and to disseminate broadcast the knowledge which they made. The story of the labours of that group of naturalists—Lyell, Darwin, the Hookers, Wallace, Huxley, Galton, and others scarcely less distinguished—has been told so often that there is no need to re-tell it now. Nor need I recount the work of Hooker. His discoveries are known and require no re-enumeration. They are incorporated with the common fund of knowledge. British botanists will determine, doubtless, to consecrate a special occasion to the commemoration of Hooker's services to science and to the perpetuation of his memory. My duty it is to express, on behalf of native botanists and of our guests who honour us with their presence, our sense of loss in the death of Sir Joseph Hooker and our admiring recognition of his achievements.

And with the example of that long life devoted until its latest hour to the pursuit of science, I would fain address myself forthwith to my special task; but despite my will I find my thoughts enchained in the contemplation of the life and times of Hooker. Systematist, explorer, critic, writer, administrator, Sir Joseph was first and last a botanist. The versatile Hooker was a specialist.

Thus I find myself turned again to the thoughts which vexed my mind at the outset of this address, urged now to ask outright whether the specialisation of our times has the quality which distinguished that of Hooker and his contemporaries.

This is the uneasy phantom that has been haunting me and luring me to the ramparts when I should be wooing my chosen theme. It haunts me, refusing to be laid. Reason fails to exorcise that ghost. Its uneasy presence lingers near me even though I conjure it with specious argument; urging that these days are days of specialisation *à outrance*: that nowadays both in the art and practice part of life we live by the intensive cultivation of small-holdings; that the fields of science are parcelled out in small allotments. Were I—a simple officer—the sole subject of this visitation I should attribute it to fantasy, and with Horatio cry "Tush!" but beside this poor Bernardo, Marcellus, officer and scholar, has likewise seen it "in the same figure like the King that's dead," and who may refuse to entertain a ghost presenting this—the highest of credentials?

Therefore I offer it again my arguments, insisting that at least among our elders we have specialists as versatile as any of the Victorians. The ghost is not impressed. Instead, it rises to a fuller height, and lays its incorporeal finger on the row of volumes which line the shelves above my head. My obsequious eye follows the direction, and beholds Lyell's "Principles," Darwin's "Voyage," Hooker's "Journal," Huxley's "Essays," Wallace's "Island Life," Galton's "Natural Inheritance," and the other classics from his clients' pens. With the dawn of my comprehension the spectre vanishes, and I am alone, but not in peace. The message left with me appears to translate as follows: The present generation has become expert in intensive cultivation of scientific knowledge, but it has forgotten how to market its produce. In the preoccupation of specialisation it neglects the art of expression. It sinks the artist in the artisan. Each specialist exchanges "separates"—hateful term—with other specialists, but few among us are on speaking terms with the cultured general public curious to know what science is achieving.

The translation into common English of our scientific works is done, like that of foreign classics, too much by hacks and amateurs, and too little by skilled hands. The present generation lets its modesty wrong it; for the science of our day is no less full—nay, many times more full—of interest and wonder than that of fifty years ago.

Still worse: to fail to cultivate the art of expression is to blunt the power of thinking, for the adage "clear thinking means clear writing" stands though the subject and object be transposed.

Such is the nature of the charge which my visitant left with me; and though, as it must have known, my rough translation fails to convey the sober grace of the original, I think that I shall not be alone in pleading guilty to that charge.

Nor perhaps will my fellow-specialists resent an attempt to trace the origin of our lack of literary grace. This defect is in part inevitable and in part remediable. Inevitable because of the increasingly engrossing nature of scientific investigation, because of the relatively small natural gift of expression which nature has vouchsafed to the English race, and because, as science becomes more complex, its followers think more and more in symbols, and those who think in symbols are apt to write in shorthand. The defect is remediable because it is traceable in some measure to the training to which we submit our youth. That training neglects too much the literary side of education.

As it seems to me, there is a fundamental error in our mode of training men of science. The error consists in this: that students who come to English universities are treated in intellectual matters not as youths but as men of mature minds. The professorial potter takes the clay as he finds it, and, no matter what its state, fires it forthwith, and lo! in course of time it is converted into earthenware. Were the assumption on which he acts well-founded, the method might be justified. If our undergraduates were, as we assume they are, well found in general culture, trained already in scientific method, familiar with the language of our fathers, and apt also to read and speak and write some other tongue, then let us take them straightway and bake them in the oven of specialisation.

But I at all events have never met those students, and, outside the ranks of genius—which training toucheth not—I believe they do not exist. The error, as I conceive it, lies in our failure to apply, in drafting schemes of training, the biological law that as society grows older its young men grow younger. Undergraduates call themselves men, not solely from a sense of pride, but also in obedience to tradition. Centuries ago they went up to the university as men of fifteen or sixteen; now they go up as youths of eighteen or nineteen. With respect to moral discipline we are not unforgetful of their youth, but with respect to intellectual education we treat them as though they were grown up. Even the saving second subject has, I am told, been discarded from the final honours course. Let me give an example in illustration of our methods. It is found that a student in his second or third year knows no German, and we advise him to learn it. But in what a way, with our tacit approval, does he set about the task! So that he may tear the meaning from a scientific text as John Ridd clutched the arm of Carver Doone and tore the muscle out of it as the string comes out of an orange!

This barbarism we permit, because we know that it is no barbarism but expediency for a trained workman to take up any tool he needs and to use it as he wills. In the elegant language of modern literature, "and what he thought he'd most require he went and took the same as we."

Yet, unless we hold that mental training is a scholastic fiction, and that the teacher's sole business is to supply carefully selected and copious provender for the stuffing of students like Surrey fowls, it must be our care to encourage general as well as special culture in our students.

A further criticism which I have to make upon our university methods will seem to some far-fetched. We are prone to forget that the twin gifts of youth are enthusiasm and idleness. The former we encourage, but the latter, falling within the category of morals, we visit with our displeasure. There is, however, an idleness which is not laziness, but a resting period of the organism tired with the trouble of growing up. I could wish that our English universities understood intellectual liberty as well as German universities understand it. We are apt to mind our sheep too much, and to overrate the virtue of docility.

I would plead for more breadth and less special knowledge, for more licensed freedom, a lesser uniformity, a wider search for gifts, and a slighter regard for specialist attainments. It is never too late for a well-trained mind to master a new subject, but he who neglects the substance of education for the shadow of mere knowledge robs himself of half the pleasure of his work and of every chance of greatness.

In attempting thus to diagnose a complaint which some may think is non-existent, I have laid myself open to attack at every point; yet I have a flickering hope that I may be dealt with after the manner prayed for by an examinee whose paper, which I read, contained the appeal: "Mr. Examiner, please temper justice with mercy, for I am so young in mind." This hope I base upon the facts that modern science has at least taught tolerance, and that I have ever found my botanist colleagues conspicuous for this virtue. They understand that even the most minor among prophets prefers the stake to silence, and their good humour acquiesces in the interchange of rôles whereby the martyrdom which should be his is borne by them in listening to his wrathful words.

Anticipation of toleration so undeserved leads me to regret almost that I ever introduced that ghost at all. For now that it has served my purpose I am free to admit that I might have laid it long ago by other and *tu-quoque* arts.

I, too, might have pointed to those shelves, and at the sight of Mendel's work it would have vanished with a blush. For with all their gracious gifts the Victorians whose just praises I have sung failed to discover that Mendel was alive among them, and showing a way to solve the problems over which they themselves were puzzling.

The merit of the discovery of the greatness of Mendel's work belongs to our generation, and those of us who had no share in it have at least the right to applaud the discoverers and to score the discovery to our side.

So I may conclude the contrast of Victorian with modern naturalists with the reflection: theirs, the higher meed of culture; ours, perhaps, the greater perspicacity.

If, as I am prepared to maintain, the greatest gift which an experimental science may receive is that of a new, serviceable, general method, then to no man are biologists more indebted than to Mendel, for such a method he gave to our science. If, further, this claim can be established, I am absolved from the task of answering the critics of Mendelian doctrine.

Who does not recollect the answer which John Hunter gave to someone—Jenner, perhaps—who wrote to that great experimenter expressing doubt of the validity of an hypothesis? "Don't think—try," was Hunter's fine response.

If it were my purpose to discourse on Mendelian doctrine, it would be my duty to carry on that work—like the early builders of that doctrine—with sword in one hand and trowel in the other, and to try in emulation of the pioneers to take an equal joy in using either implement. But my work concerns the method and facts accomplished by its use, and, as I understand philosophy, the writ of criticism does not run in the domain of accomplished fact. A homely illustration will serve to define my attitude. Here is a new knife, and there an old loaf, the crust of which has turned the edge of other implements. If with this knife I cut that loaf, it is idle to tell me that my knife is blunt. One form of criticism, and one only, is valid in such circumstances, and that is the constructive criticism of offering a better instrument. If I want bread, and Mendel's knife can give it to me, I shall go on cutting, indifferent to the stones of destructive criticism.

My business, therefore, is to meet criticism, not by dialectics, but by confronting it with the facts accomplished by this method and by showing that its use opens new pathways on the borders of the unknown.

Now, if we scrutinise the method of Mendelian research, we may see that there can be no criticism of it.

Give a chemist a complex mixture of many compounds to describe: how does he proceed? The chemist sorts out the ingredients, and submits them severally to analysis. Such, also, is the method of the Mendelian analyst. Give him that complex mixture which is called an individual, and he sorts out the ingredients and submits them to analysis. Ask him how two complex mixtures behave when they are bred together, and he re-defines the question in such terms that it ceases to be enigmatical, and becomes susceptible of solution by experiment.

I am not concerned to claim for the Mendelian method the exclusive possession of these virtues. All I claim is that for the work of making a physiological analysis of individuals, and of thereby establishing a physiological classification of plants and animals, the Mendelian method has proved its value. It effects the service by a simultaneous analysis of germ and soma.

Let it be conceded at the outset that this analysis is made, not by direct but by indirect methods. For so long as the physical nature of living substance remains unknown we can scarcely hope to resolve an individual into its physical components. All that can be done is to make comparative analyses of individuals and to discover how their several components differ from one another.

For our present purpose we may represent the individual by an equation:—Individual $= x + c$; where c represents the sum of a long series of characters of the individual and x an imaginary or real groundwork left after all the Mendelian characters the sum of which is c have been removed by analysis from the individual. The Mendelian method is concerned directly with the resolution of c into its components. Indirectly it is concerned also with x; for by the pursuit of the method the full value of c may be determined, and hence that of x may be inferred. This concession made, it is permissible to concentrate our attention on the term c.

Thus the business of the Mendelian is to resolve the complex of characters which is possessed by an individual into its constituent unit characters. As a consequence of this experimental analysis Mendelism is enabled to restate the problem of the behaviour in inheritance of two individuals in these terms:—

The complex of characteristics which distinguishes an individual is the expression of the sum of a long series of characters. As the individual arises from germ cells so each character arises from a germ within the germ cells. Such germs of characters are called factors. When two germ cells unite to form an incipient individual or zygote they bring together the similar factors of a given character—one factor from the one germ cell and the other from the other. As the zygote forms the mature individual, so the paired factors give rise to a character of the individual.

The body characters are the flowers of the factorial seeds implanted in the germ cells.

Some characters are simple and derive from one pair of factors only; others are of an ascending order of complexity and may be traced to the co-operative agency of two, or more than two, pairs of factors. In the case of a complex character the determining factors may be unlike one another or they may be alike. Thus two pairs of different factors are required to produce the character of colour in certain flowers; on the other hand, it is at least probable that certain characters are the outcome of repeated doses of the same factorial stimulant. Further, the individual is a dual thing—a double-barrelled gun. Each barrel is loaded with the factorial charge supplied by one of the two gametes by the union of which its duality is constituted. Conversely and consequently a gamete or germ cell is, in comparison with the individual, of single and not of dual nature. It has one barrel only, and therefore can carry or give effect to one, and only one, of the two factorial charges with which the individual was supplied at the time of its formation.

Our image of the double-barrelled gun serves also to illustrate the several states in which an individual may find itself with respect to its charge of factors of any given simple body character.

Both barrels of the gun may be loaded. An individual in like state possesses two factorial charges and produces gametes, all of which are alike in the possession of one of these factors. Therefore, such an individual, when self-fertilised, or mated with its like, produces gametes which are all alike in this respect, and these gametes, fusing in pairs, give rise to individuals which all possess the character in question. Such individuals are homozygous, they breed true to the character.

Neither barrel may be loaded; and an individual in like state is also homozygous. It breeds true to the absence of the character. If a gamete of the former individual meet with one from the latter individual, the resulting zygote is in like case with that of a double-barrelled gun of which one chamber only is loaded. The zygote is heterozygous for the character. Unlike the homozygotes, which breed true, the heterozygous individual does not breed true to the character in question.

By the application of the foregoing propositions and a little arithmetic, it may be predicted that the offspring of the heterozygote fall into three groups—one homozygous for the character, and another heterozygous, and a third homozygous for the absence of the character—and that, further, these types of individuals occur in the proportion of 1 : 2 : 1. Needless to say, the prediction is susceptible of verification by experimental breeding from the heterozygote. These are Mendelian commonplaces with which I should have hesitated to occupy our time were it not for the fact that I desire to emphasise the epoch-making nature of Mendel's method. The magic wrought by genius is potent because it is simple. The rules of Mendelian method are simple. If it be urged that I have broken my promise and strayed from method to doctrine I would ask which of the simple propositions I have stated may be demurred to by any student of biology?

The supreme importance of Mendel's contribution to science consists in this: that instead of mixing anything with anything "in the gruel thick and slab" of a witches' cauldron, he has taught us to cast the horoscope of Fate by the method of genetical analysis of individual characters. Thus the first part of the Mendelian restatement of the old problem of heredity reads: Investigate one by one the modes of inheritance of the several characters of an individual. Choose for this purpose organisms which are as far as possible alike in all respects except for the character under investigation. Carry the experiment to its conclusion, even to the third or fourth generation. If uncertain results are obtained, ascertain before discarding the method whether the uncertainty may not be due to the interference of other characters not to be suspected *a priori* of exercising an influence upon the expression of the character under investigation.

Who, for example, would suspect a morphological character like thickness of stem of exercising an influence on the time of flowering of a plant? Yet such is the case with the pea (*Pisum sativum*), and there is evidence that when this disturbing influence is removed inheritance of time of flowering follows Mendelian rules.

The second part of the restatement of the problem of genetics may be expressed as follows: Only by the use of individuals of proved constitution with respect to a given character may the effect of external conditions on organisms be determined. The study of variation must be preceded by Mendelian analysis and synthesis. Let me illustrate this theme by an example.

The species, *Primula sinensis*, the Chinese primrose, has given rise to many distinct varieties. Among these varieties are some with white flowers and others with magenta, blue, red, or other coloured flowers. Each of these varieties may be obtained of florists in a pure strain—that is to say, in a strain which breeds true to flower-character. For our immediate purpose we will group these varieties into white and coloured forms.

It has been shown, however, that this apparently natural mode of grouping is inadequate to give a correct idea of the genetic constitutions of these races. It would seem self-evident that the white races differ from the coloured races by the lack of flower-pigment; yet Mendelian analysis demonstrates that there are more subtle differences between the different races. These differences become apparent when true-breeding white and coloured plants are crossed with one another; for it is then discovered that two types of white-flowered plants exist, and it is only by their fruits—their offspring—that ye may know them. Thus if certain white-flowered races are chosen for the experiment, the result of crossing white and colour is a coloured F_1 generation. If certain other white races are used and mated with the coloured form the offspring of the cross all bear white flowers. The different genetical behaviours of these heterozygous first generations give the clue to the difference between the two forms of white used as parents. In the former case—that in which the first (F_1) generation consists of coloured offspring—the second (F_2) generation, raised by self-fertilising F_1 individuals or by crossing them with one another, consists of coloured : white in the proportion of 3 : 1.

Whence we conclude that the white used in this experiment owes its character of whiteness to lack of the pigment-producing factor which is present in the coloured parent race. This conclusion is confirmed by the genetical behaviour of the whites of the F_2 generation. Such extracted whites breed true to flower-character—that is, give rise to white-flowered offspring only. White-flowered races which behave in this manner are termed recessive whites.

In the second case—that in which the F_1 generation consists of white-flowered offspring—the F_2 generation, from selfed or intercrossed F_1 plants, consists of three white : one coloured. The coloured offspring breed true. Of the three whites one breeds true to whiteness and the other two give rise, like the white F_1 generation, to three white : one colour. White races which thus impose their whiteness on the offspring of their union with a coloured race are known as dominant whites. Mendelians account for the genetical behaviour of dominant whites by assuming that they carry the character for colour and also a character for colour-inhibition. This hypothesis, which is novel to biology, is amply justified by genetical results. It propounds a series of questions to the physiologist and biochemist, and in so doing exemplifies the fruitfulness of Mendelism. We shall see immediately whether the biochemist is able to take up this Mendelian challenge and what answer he can give to it.

At present, however, we are concerned to show by an example the necessity of prefacing the study of variation by Mendelian analysis. It was stated just now that the cross, dominant white by colour, results in a white F_1. That statement requires amplification. Grown under normal conditions the F_1 individuals bear pure white flowers; but if grown in somewhat higher temperatures the flowers develop a distinct though pale flush of colour. It is easy to show that the factor for colour is unaffected by the changed conditions, for the flushed F_1 individuals yield offspring of the same kind and in the same proportions as those produced by white F_1 plants.

It is fairly evident that the flushing is produced by the destructive action of heat on the inhibitor. In pre-Mendelian times this response to temperature would have been added without more ado as yet another ornament to dress the window of that old curiosity shop which is stocked with miscellaneous and heterogeneous articles all ticketed with the label "variation."

But in the light of Mendelism we may see in this effect of temperature the result of the casting-vote of circumstance on a heterozygous constitution. We may recall instances—as, for example, those provided by the well-known experiments on the effects of high temperatures on insect larvæ—which seem to show that environmental agencies may single out not only characters but also factors for attack. Thus we may begin to cohere in series the hitherto sundered and scattered phenomena of variation.

It is not yet possible to say how much of variation is to be put down to the interplay of characters, or, rather, to the differential effects of external conditions on characters which tend to balance one another; but this at least may be said—that the old and worn controversy on acquired characters was so much waste of words, because the problem purporting to be discussed had never been defined. Like the half of human quarrels, it was a quarrel about words.

It is stated in the books that the formation of peloric (regular) flowers may be induced by uniform illumination. Was the material used in the research homozygous or heterozygous? Does uniform illumination just prevent the unpaired factor from inducing normal growth? If so, what is the effect on the homozygous normal? These are examples of questions which suggest themselves at every turn, and they will abide the answer of experiment. The time is approaching when it will be possible to test the validity of the hypothesis on which the superhypothesis of natural selection rests apparently secure from verification or disproof.

That hypothesis maintains that everything is in a state of flux; that variation occurs at all times and affects all parts. This may be true of multiple mongrels; of organisms which are heterozygous for many characters. On the other hand, nothing is more surprising than the stability of forms which are pure-bred for a fair number of characters, and it is at all events a suggestion not to be rejected summarily that plants pure bred for a considerable number of characters may exhibit a constancy and stability not usually associated with our ideas of living things.

In any case, it is open to the biologist to provide himself with suitable material wherewith to study the range and scope of variation and to investigate the conditions under which the organism discards old characters and regresses or acquires new ones and progresses. It is open to the Mendelian breeder to standardise creation.

Thus in fulfilling the first part of its task—that of defining the pure-bred—the Mendelian method has provided the material for the fulfilment of the second part—namely, the investigation of the conditions which make for the stability and instability of the organism. I think the time has come when this latter task might be undertaken on a large scale and with good prospects of success.

So far I have played the part of one of those street-corner watchers of the skies who offer a telescope for the inspection of the heavens. I have now to take a turn myself, and by means of the binoculars of Mendelism and physiology survey, not the celestial bodies, but certain new features of a small and narrow terrestrial field which this instrument brings within our ken. My survey has reference to the phenomena of the pigmentation of plants, and is confined to those presented by the anthocyan or sap pigments to which the colours of many flowers are due.

Until recently knowledge of the processes of pigmentation advanced along two main and independent lines. One line of advance—that followed with such brilliant success by Bateson and the Cambridge school, as well as by other students of genetics—has led to a wealth of exact knowledge with respect to the factors and characters which determine coloration. The other line of advance, pursued with no less brilliant results by Chodat and Bach and by Palladin and his associates, has resulted in a great increase of our understanding of the biochemistry of pigmentation.

The merit of being the first to combine the genetical with the biochemical method belongs to Miss Wheldale, to whom, moreover, we owe a good working hypothesis of the nature of the processes involved in pigment-formation. The work of Palladin and of Chodat and Bach is so well known that I need not review it in any detail. To Palladin we owe in large measure the conception that respiration consists in a sequence of enzyme-like actions, the later of which result in oxidations and are ascribed to oxydases. To the same observer we owe also the suggestion that chromogens play a part in the oxidations set up by oxydases, and that these colourless chromogens may undergo either alternate oxidation and reduction and so take a continuous part in oxydase action, or undergo permanent oxidation and so constitute the pigments of the plant.

Chodat and Bach have given us a serviceable conception of the nature of oxydases. According to the Chodat-Bach hypothesis, oxydases are of dual nature; the complete oxydase consisting of two parts—a peroxydase and an organic peroxide. An oxydase reacts with oxidisable reagents, such as guaiacum, to produce a characteristically coloured product. Hence these reagents may be termed oxydase-reagents. Peroxydases react with oxydase reagents only if there be added, as a substitute for the organic peroxide of the complete oxydase, a source of active oxygen in the form of hydrogen peroxide. Both oxydases and peroxydases occur in the cells of plants, and may be identified in extracts therefrom.

The work of Görtner on the pigments of insects adds confirmation to the view that pigments are the product of the action of oxydase on chromogens. Thus he has shown that the black or brown melanin of the integuments of insects is produced by the action of an oxydase, tyrosinase, on some such product of protein-hydrolysis as tyrosin.

Miss Wheldale's studies have led her to formulate the hypothesis that the anthocyan pigments of plants are the outcome of a series of chemical changes of the following order: Glucosides hydrolysed by emulsin yield chromogens which, acted on by oxydases, give rise to anthocyan pigments. The difficulty in the way of further advance lay in the unsatisfactory nature of the methods for identifying oxydases derived from plant tissues. Hence when we turned our attention to this subject Dr. E. F. Armstrong and I made it our first task to search for means whereby we should be able not only to identify, but also to locate, oxydases and peroxydases in plant-tissues. Clarke had tested already numerous oxydase-reagents and found that certain among them are adapted for microchemical use. As the result of a considerable number of trials of known reagents we have found that α-naphthol and benzidine are each adapted admirably for the purpose of locating oxydases. By means of these reagents we have been able to map out the distribution of oxydase and peroxydase in the flowers and other parts of various plants, and although the work is laborious and the technique as yet imperfect, the results afford strong confirmation of the current hypothesis of the mode of formation of anthocyan pigments. This confirmation, however, was rendered possible only by reason of the fact that we worked with races of plants bred on Mendelian lines, and hence of known genetic constitutions.

Our method of investigation is briefly as follows. The oxydase-reagent is used in weak alcoholic solution, the part of the plant to be tested is incubated in the solution for a suitable time, and if no oxydase action takes place—that is, if no characteristic coloration of the tissues occurs—the material is tested for peroxydase by the addition of hydrogen peroxide. The method may be employed for intact corollas or petals or for sections of plant-tissues.

It is important to mention that the first result of immersing a sap-pigmented tissue in either reagent is the decolorisation of the tissue. For example, a corolla of a coloured-flowered race of *Primula sinensis* loses its colour completely after being immersed for an hour or two in either reagent. The decolorised corolla, which in the case of *P. sinensis* remains colourless, is treated with hydrogen peroxide, with the result that a well-marked peroxydase reaction is obtained. The reaction is confined to the non-chlorophyllous parts of the corolla, and does not occur, except in the epidermal hairs, in the region of the yellow or green eye, the tissues of which contain chlorophyll. Indeed, there is good reason to believe that chlorophyll inhibits oxydase action.

By treating similar flowers with each of our two reagents we find that the action of α-naphthol and benzidine are, in a considerable measure, supplementary one of the other. Thus the lilac-blue α-naphthol reaction is confined, or almost confined, to the veins of the corolla, the brown benzidine reaction is exhibited by the superficial (epidermal) cells and also by the veins. In order to emphasise the facts of distribution we speak of the peroxydases of *P. sinensis* as epidermal peroxydase and bundle oxydase. The former occurs in the epidermis and in the epidermal hairs, the latter in the bundle sheath which accompanies the veins.

Similarly, if sections of a stem of *P. sinensis* be investigated they are found to contain a superficial peroxydase and a deep-seated peroxydase. As the result of investigating the peroxydases, not of any unknown variety taken at hazard, but of the several varieties characterised by constant differences of depth and extent of pigmentation, we have been able to show that the distribution of peroxydase in any one race coincides broadly with the distribution of pigment in the most pigmented races. In other words, in *P. sinensis* the peroxydase framework for pigmentation occurs throughout the species, and the building of the several colour varieties is determined by the activity of the factor for chromogen production. If we conceive of this factor as administered in a series of doses we can form a fair picture of the mode of evolution of the series of varieties characterised by increasing or decreasing amount of pigmentation of their vegetative parts.

On turning to investigate the peroxydases in white-flowered races of *P. sinensis*, we shall expect to find from analogy with the peroxydases of the stem that these agents of pigment-formation are not lacking from the corollas of recessive whites. The application of our reagents shows that this expectation is correct, and that those white-flowered races which lack the factor for colour contain epidermal and bundle peroxydase. Hence we conclude that the absence of colour from recessive white flowers is due, not to the absence of peroxydase, but to absence of chromogen. This conclusion is in conformity with that arrived at previously by Mendelian methods; for, as we have noted already, these methods demonstrate that anthocyan pigmentation of the flower of *P. sinensis* depends on the presence of one factor only, and that the absence of pigmentation which is characteristic of recessive whites is due to the absence of that single colour-factor.

The result of our investigation of the peroxydases of dominant white flowers is, on the other hand, quite different from that given by recessive whites. When corollas of dominant white races are treated with α-naphthol or benzidine and subsequently with hydrogen peroxide, they show no sign of peroxydase neither in epidermis nor in bundles. Hence such flowers either lack peroxydase or else they contain a substance which inhibits peroxydase from exercising its oxidising action on our oxydase-indicators.

That oxydases may be inhibited *in vitro* has been demonstrated already by Görtner, who has shown that the addition of certain phenolic compounds—orcin, resorcin, &c., prevents tyrosinase from exercising its characteristic action upon tyrosin.

Assuming that an inhibitor of peroxydase occurs in dominant white flowers, it may be supposed to act either by destroying peroxydase or by setting up conditions under which the activity of peroxydase is arrested. Assuming further that the inhibitor acts in the latter way, it follows that if means of destroying or removing the inhibitor be discovered and employed, the peroxydase released from the inhibitory grip should be free to effect the oxidation of our reagents.

This train of reasoning gave us a point of departure for experiment. Starting from this point Dr. Armstrong and I have found in hydrogen cyanide a means of removing peroxydase-inhibition. Thus if dominant white flowers are immersed in a 0·4 per cent. solution of hydrogen cyanide for twenty-four hours, washed, and treated with either of our reagents together with hydrogen peroxide, pronounced peroxydase reactions are obtained, both in the epidermal and bundle tissues of the corolla. Carbon dioxide in aqueous solution produces a like, albeit a less pronounced effect.

Now, it so happened that we had at our disposal a race of primulas, the flowers of which lend themselves peculiarly well to the purpose of confirming these observations. The race in question is characterised by blue flowers with fairly symmetrically placed paired white patches on each petal. We have reason to believe from the known ancestry of this race that these white patches are produced by a localised inhibitor.

Corollas of these flowers treated with α-naphthol or benzidine become quite colourless. When, however, hydrogen peroxide is added the natural pattern is restored. The parts originally blue are stained lilac-blue or brown, according to the reagent used, and the inhibitory patches stand out as in the intact flower as white areas on the coloured ground.

If instead of submitting the parti-coloured flowers directly to the oxydase reagent they are treated first with hydrogen cyanide, and then treated with the reagent and subsequently with hydrogen peroxide, the inhibition located in the white areas is found to have been removed, and the peroxydase reaction is produced over blue and white areas alike.

Hence the Mendelian hypothesis of the inhibitory nature of dominant whites is confirmed by biochemical methods. Moreover, these methods demonstrate that the inhibitor acts not by destroying but by preventing the action of oxydase upon the chromogen.

There are many other aspects presented by the phenomena of oxydase distribution in *P. sinensis* and other plants which we have investigated. Some I may enumerate, but lack of time must be my excuse for not dealing fully with any of them.

The close proximity in the flower of the superficial and deep oxydases suggests that the latter may co-operate with the former in producing flower-pigments. This possibility entails the hypothesis of a translocation of oxydase from the region in which it is secreted to that in which it acts, and there are not a few facts which are in favour of this view; for example, the lines of deep colour which occur along the veins of many flowers, the frequency with which the walls of cells appear to contain oxydase, the occurrence of oxydase in the mesophyll cells which adjoin the bundle sheath, and the evidence provided by the mutual influence of stock and scion in grafted plants and in graft hybrids. Though these and other subjects must be passed over, I cannot resist giving what appears to me to be the most elegant mode of demonstrating the relation between oxydases and pigmentation which we have as yet observed. The plant which has served for this purpose is the sweet William (*Dianthus barbatus*), and any of the old-fashioned races of this plant common in cottage gardens suffices, provided that it be an ever-sporting race. Such a race is known by the fact that it bears, on one and the same head, flowers of different colours. The race which we have used is very sporting, a single plant bearing in one inflorescence deep magenta, pale magenta, white with limited rose flush, and all but pure white flowers.

If a petal of each of these flowers be treated with the benzidine reagent, it is found that the extent and amount of the oxydase reaction, as measured by the distribution and depth of brown coloration indicative of oxydase, coincide precisely with the extent and amount of pigmentation. The full-coloured petal gives a uniform deep brown reaction, the light magenta a uniform but paler reaction, the petal with a limited rosy flush gives a slight reaction, limited to the pigmented area, and the all-but-white petal gives none but the slightest reaction, and that only in the part of the petal which contained traces of pigment. Thus—unless the results are due to a partial inhibition which has eluded our attempts at demonstration—it would seem established that the ever-sporting habit is due to differences in the amount of oxydase in the diversely coloured flowers.

The sweet William is also noteworthy in that it contains white races, some of which give an oxydase reaction in their petals, and some of which give no oxydase reaction. Breeding experiments now in progress will decide whether or no these white races, like those of sweet peas investigated by Bateson and Punnett, mated together yield coloured progeny. If so, the factors for colour, long wandering yet not lost, which meet again in reversionary coloured cross-breeds, may prove to be a chromogen factor and an oxydase factor.

Finally, a brief reference must be made to our observations on the periodic fluctuation of oxydase in plants. Various observers have noticed that plant tissues give the peroxydase reaction much more generally than the oxydase reaction. The observations now to be described indicate that this is due to the greater stability of peroxydase as compared with the organic peroxide.

In certain circumstances a tissue which gives only the peroxydase reaction may exhibit the direct oxydase reaction. Moreover, the extent of the peroxydase reaction, as judged by the depth of coloration of the reagent, varies in similar plants at different times.

Inquiry into the meaning of these fluctuations led us to the discovery that the nature and amount of oxydase contained in a plant tissue varies in an orderly manner according to external conditions.

Among the conditions which determine this fluctuation are light and darkness. Plants subjected to normal illumination possess less oxydase than those which are kept in darkness. After one or two days' exposure to darkness plants of *P. sinensis* contain more peroxydase than sister plants kept under normal conditions of illumination. Moreover, after such an exposure to darkness tissues which under normal conditions give only peroxydase-reactions yield distinct oxydase-reactions.

Whether these phenomena are general among plants we are not yet in a position to say; but repeated experiment enables us to vouch for them in the case of *P. sinensis*. Should the results of similar investigations with other plants show that this diurnal variation of the oxydase-content of plant tissues is of general occurrence, we may perhaps discover therein the means whereby many of the phenomena of periodicity exhibited by plants are maintained and regulated. We know that the light and darkness of the day and night set up rhythms in the plant; for example, that the leaves of various plants assume nocturnal and diurnal positions. We know further that the rhythm thus established may be maintained for a certain time under uniform conditions of illumination. This is the case with the sensitive plant and many another.

Animals also exhibit a like periodicity. Thus some years ago Dr. Gamble and I showed that certain shrimp-like animals, *Hippolyte varians*, roll up their brilliant chromatophores at night and assume a sky-blue colour. When daylight comes they put on their daytime dress by spreading out the pigment of their chromatophores in far-reaching superficial networks. Kept in the dark, these animals retain for many days this periodic habit, and when the hour of night arrives, although they have no light to tell it by, they lay aside their daily garb and put on the uniform of night. So also the plant-animal *Convoluta roscoffensis*, which lives on the seashore, orders its behaviour by the sun and moon. It lies on the sand till the waves of the making tide are upon it, and then descends to security and darkness. When the tide recedes it rises to the light. Even the uncongenial surroundings of a teacup and a laboratory fail to break this habit; for in these surroundings its uprisings and down-lyings keep time with the tides.

To one who has scrutinised with perplexed mind these mysteries of biology, the speculation may be permitted that light and darkness may work these wonders through the control of chemical agents such as oxydases. But though it be legitimate to make a speculation of this kind, it is idle to hunt the unknown to the death without the lethal weapon of experiment, and so I leave it for the present unpursued, and with it my address. We have it on the authority of a poet and philosopher that to the traveller on a lonely road each bush becomes a bear, and I am not oblivious of the fact that oxydases have obtruded themselves with a certain obstinacy in the course of my address. Nevertheless, obsession has its uses and significance, for it is the after-effect of enthusiasm; and though I have dealt, perhaps at undue length, with special problems and with suggestions, I venture to think that I have made out my case for the opportuneness of an *entente cordiale* between physiology and Mendelism.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Henry Sidgwick memorial lecture at Newnham College will be given by Prof. Ward in the College Hall on Saturday, November 9, at 5 p.m., and will be open to all. The subject will be "Heredity and Memory."

The prize of 50l. out of the Gordon Wigan Fund for a research in chemistry has been awarded to D. H. Peacock, of Trinity College, for investigations on "Hydroxyhydrindenehydrazine and its Resolution," "1:2:4-Triketopentamethylene," and "The Theory of Molecular Volumes."

The next combined examination for fifty-seven entrance scholarships and a large number of exhibitions, at Pembroke, Gonville and Caius, Jesus, Christ's, St. John's, and Emmanuel Colleges, will be held on Tuesday, December 3, and following days. Mathematics, classics, natural sciences, and history will be the subjects of examination at all the above-mentioned colleges. A candidate for a scholarship or exhibition at any of the six colleges must not be more than nineteen years of age on October 1, 1912. Forms of application for admission to the examination at the respective colleges may be obtained as follows:—Pembroke College, The Master; Gonville and Caius College, the Master; Jesus College, A. Gray; Christ's College, the Master; St. John's College, the Master; Emmanuel College, the Master; from any of whom further information respecting the scholarships and other matters connected with the several colleges may be obtained. The forms of application must be sent in on or before Saturday, November 23.

Colonel Harding, of Madingley Hall, has offered to the Vice-Chancellor to hand over to the University a sum which will produce an annual income of between 50*l*. and 60*l*. a year, to be devoted to the payment of a lectureship in zoology.

A SERIES of ten free public lectures upon natural history, folk-lore, and related subjects will be given in the new Lecture Hall of the Horniman Museum, Forest Hill, S.E., at 3.30 o'clock on Saturday afternoons, commencing October 12.

IT is stated in *Science* that at the September meeting of the Yale Corporation it was announced that since the last meeting three wills have been filed for probate from which Yale University will probably receive during the year about 150,000*l*. These bequests include 50,000*l*., unrestricted, by bequest of Mr. Matthew C. D. Borden, and the McPherson fund of between 80,000*l*. and 100,000*l*., "to be employed in assisting worthy indigent students."

A COPY of the second issue of the "Register of Old Students of the Royal College of Science, London," compiled by the Old Students' Association, has been received. An excellently reproduced photograph of Sir William Crookes, O.M., F.R.S., the president of the association, serves as a frontispiece to the register. The names of 876 old students are given; of these 729 are associates of the college, and in their cases the subjects in which they took their diplomas are enumerated. Copies of the register may be obtained, price 1*s*. net, from Messrs. Lamley and Co., Exhibition Road, South Kensington.

THE Secretary of State for India in Council has made the following appointments to the Indian Educational Service:—Dr. W. N. F. Woodland to be professor of zoology at the Muir Central College, Allahabad; Dr. A. N. Meldrum to be professor of physics and chemistry at the Institute of Science, Ahmedabad; Mr. W. S. Rowlands to be professor of philosophy at the Government College, Jubbulpore; Mr. G. H. Luce to be professor of English at the Government College, Rangoon; and Mr. C. S. Gibson to be additional professor of chemistry at his Highness the Maharaja's College, Trivandrum, in the Travancore State Service.

AT the University of Leeds on October 3 honorary degrees were conferred upon Mr. Arthur Cooper, president of the Iron and Steel Institute; Sir Robert Hadfield, F.R.S., a past president of the institute; M. Adolphe Greiner, of Liége; Herr Friedrich Springorum and Mr. J. E. Stead, F.R.S., members of the council of the institute; Mr. Corbet Woodall, Mr. Charles Carpenter, and Mr. Thomas Newbigging, for their services to science in the gas industry; and Sir Swire Smith, Mrs. R. W. Eddison, Mr. W. E. Garforth, and the Rev. W. H. Keeling, headmaster of Bradford Grammar School, for their services to science and education in Yorkshire.

THE students of forestry in Edinburgh University, as part of their practical training, have during August and September been camping out at the Drumbuick Wood, Methven, Perthshire, and part of the Logiealmond estate of the Earl of Mansfield, so as to have the opportunity of measuring timber. The trees were principally Scots pine, larch, and spruce, and these were numbered and measured. The accessible trees were dealt with in detail in 10-ft. sections, while every tenth was barked so as to obtain the allowance necessary to be made for bark. The work of the students was supervised by Mr. Lyford-Pike, junior lecturer in the University, who was assisted by a few recent graduates in forestry.

DR. L. SILBERSTEIN will commence a course of twelve lectures on "The Theory of Relativity" at University College, Gower Street, W.C., to-morrow, October 11, at 5 p.m. The first part of the course will be historical, beginning with Maxwell's electromagnetic theory, and the Hertz-Heaviside equations; the second part will be concerned with the principle itself; and the third with its applications and recent extensions. Much attention has been paid to the subject since Einstein founded the modern theory in 1905, but the arguments for the principle, and the conclusions to which they lead, are not well understood. There must be many students of physics who will be glad to have a clear and connected statement of a theory which, carried to its furthest extent, would declare that "the phenomena of physical science do not lead us to any knowledge of a permanent and unique frame of reference relative to which the motions of bodies may be determined."

COPIES of the calendar for the academic year, 1912–13, of the University of Leeds are now available. As is natural in the case of a great modern university, the faculties of science and technology take a prominent place in the activities connected with the institution. The degree of bachelor of science, whether with or without honours, may be taken in pure or applied science. The student wishing to graduate on the technical side may study mechanical, civil, electrical, mining, or gas engineering, fuel and metallurgy, agriculture, colour chemistry and dyeing, or the chemistry of leather manufacture, and, if successful, secure his degree. In addition, the University grants diplomas in certain circumstances in the branches of applied science in which degrees are awarded, and also in textile design and cloth finishing, in woollen and worsted spinning, cloth manufacture, and textile chemistry. Evening classes in a wide range of subjects are also provided for students whose time is occupied in industrial pursuits during the day.

AN interesting short history of Bedford College for Women is included in the calendar for the sixty-fourth session, that of 1912–13, of the college, which was recognised in 1900 as a school of the University of London in the faculties of arts and science. It will be remembered that a bequest in 1908 of 11,500*l.* from the late Mr. R. J. Turle enabled the council in the same year to purchase the end of the lease of South Villa, Regent's Park, for the sum of 15,000*l.*, a promise from the Crown having been obtained of a new lease for 99 years. The site is an ideal one. New buildings, for which Mr. Basil Champneys has been appointed architect, and will include a library, laboratories, lecture rooms, and a residence for students, are now in course of erection, and it is hoped that they will be ready for occupation by next Easter. It is estimated that the cost of the undertaking will amount to about 115,000*l.*, including 18,000*l.* which has been expended in connection with the purchase of the lease of the new site. The total sum given and promised amounts to 130,000*l.*, which leaves 15,000*l.* to form the nucleus of an endowment fund.

THE calendar of the North of Scotland College of Agriculture for the session 1912–13 points out that the classes of the college are held in the University of Aberdeen, with the exception of the class in agricultural engineering, which meets in Robert Gordon's Technical College. The courses of instruction provided are arranged for the benefit of every section of the agricultural community. The lectures, in the branches of agriculture and agricultural chemistry, are arranged in a series of three years with the view of giving full treatment to these subjects. Students unable to spare the time for a long course in agricultural science, but who can spare five months in winter, have an opportunity of obtaining a diploma in agriculture conferred by the University. Young men and women who wish to qualify themselves as agricultural teachers or as specialists in some branch of agricultural science may obtain the degree of bachelor of science of the University on passing the preliminary examination of the University and two professional examinations. Extended courses of lectures in forestry are arranged for those desirous of training as factors and land stewards; courses for teachers in school gardening and other subjects required in rural districts are provided, and every effort is being made to supply suitable technical education for the district.

THE *London University Gazette* for September 25 announces a number of courses of advanced lectures in various subjects, among them being a course of three or four lectures on "The Theory of the Solid State," by Prof. W. Nernst, professor of physical chemistry and director of the Institute of Physical Chemistry in the University of Berlin. Other courses to be delivered during the session are :—The fundamental chemical processes of plant life, Prof. H. E. Armstrong, F.R.S.; the Gnetales, Prof. M. J. Benson; the permeability of protoplasm, F. F. Blackman, F.R.S.; the activities of green plants in relation to light, Harold Wager, F.R.S.; meteorology in relation to the navigation of the air, Dr. W. N. Shaw, F.R.S.; the action of enzymes, Prof. W. M. Bayliss, F.R.S.; the physiology of the mammalian heart, Dr. F. S. Locke; protozoa, Prof. E. A. Minchin, F.R.S.; the growth of the vertebrate embryo, R. Assheton; recent work on experimental embryology, Dr. J. W. Jenkinson; mimicry and protective resemblance, Prof. E. B. Poulton, F.R.S.; the evolution of the mammary apparatus in the mammalia, Prof. E. Bresslau, of Strassburg; growth and form, Prof. D'Arcy Thompson, C.B.; the advanced metallurgy of gold, silver, copper, lead, &c., Prof. W. Gowland, F.R.S.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 30.—M. Émile Picard in the chair.—Edmond **Perrier**: The skull known as that of Descartes in the museum. Reasons are given for the probable authenticity of this skull.—Pierre **Termier**: The scientific results of the Alpine excursion of the Geologische Vereinigung; the lepontine strata to the west of Innsbruck.—M. **Gouy**: A particular kind of electric currents. A non-electrified body is usually regarded as carrying equal charges of the two kinds of electricity. The latter, according to current views, are carried by particles possessing a certain independence, and under certain conditions may move with different velocities. If this is the case, the movement of a non-electrified body may give rise to an electric convection current, producing its ordinary effects. This view is applied to the case of incandescent gases in motion.—M. **Arnaud**: Astronomical refraction in the neighbourhood of the horizon.—Em. **Bourquelot** and Mlle. A. **Fichtenholz**: The presence of quebrachite in the leaves of *Grevillea robusta*. The fresh leaves contain more than 4 grams of quebrachite per kilogram, or four times the amount extracted from the bark of

C. tanret. Details are given of the method of extraction and of the chemical and physical properties of the quebrachite.—A. **Fernbach**: A new form of soluble starch. Weak solutions of starch in water, not containing more than 2 per cent. of starch, are poured into a large excess of acetone, and the precipitate extracted with pure acetone, and dried in a vacuum. The starch thus obtained is distinguished by the property of dissolving easily in cold water, and this solution yields with iodine very pure blue colorations.—J. **Wolff**: Some new properties of the peroxydases and their mode of working in the absence of peroxide.—Jacques **Parisot** and M. **Vernier**: Researches on the toxicity of fungi. Their hæmolytic power. It is shown that the hæmolytic power of fungi, when it exists, is very strong, both *in vitro* and *in vivo*. This property is possessed by some of the edible fungi, and it is pointed out that a very long exposure to a high temperature during cooking is required to destroy this poisonous property.—Maurice **Lugeon**: The tectonic of the Morcles strata and its consequences.—De Montessus de **Ballore**: Seismological observations made at the island of Pâques.—Henry **Hubert**: The aërial currents in western Africa.

BOOKS RECEIVED.

Einführung in die Mathematik für Biologen und Chemiker. Prof. L. Michaelis. Pp. vii+253. (Berlin: J. Springer.) 7.80 marks.

The Cambridge Manuals of Science and Literature: The Individual in the Animal Kingdom. By J. S. Huxley. Pp. xi+167. The Work of Rain and Rivers. By Prof. T. G. Bonney. Pp. viii+144. The Psychology of Insanity. By Dr. B. Hart. Pp. ix+176. House-flies and How they Spread Disease. By Dr. C. G. Hewitt. Pp. xii+122. Brewing. By A. C. Chapman. Pp. xi+130. Heredity in the Light of Recent Research. By L. Doncaster. Second edition. Pp. x+160. (Cambridge University Press.) 1s. net each.

Die Existenz der Moleküle. By Prof. T. Svedberg. Pp. viii+243+4 plates. (Leipzig: Akademische Verlagsgesellschaft m.b.H.) 12 marks.

Untersuchungen über die Bildungsverhältnisse der ozeanischen Salzablagerungen insbesondere des Stassfurter Salzlagers. By J. H. van't Hoff and others. Edited by Profs. H. Precht and E. Cohen. Pp. xx+374+8 plates. (Leipzig: Akademische Verlagsgesellschaft m.b.H.) 16 marks.

Sylviculture in the Tropics. By A. F. Broun. Pp. xviii+309. (London: Macmillan and Co., Ltd.) 8s. 6d. net.

La Cementazione dell' Acciaio. By Dr. F. Giolitti. Pp. xi+506. (Torino: Unione Tipografico-Editrice Torinese.)

Handbuch der Spectroscopie. By Prof. H. Kayser. Sechster Band. Pp. vi+1067. (Leipzig: S. Hirzel.)

Hypnotism and Disease. By Dr. H. C. Miller. Pp. 252. (London: T. Fisher Unwin.) 5s. net.

Survey of India. Professional Paper, No. 13: Investigation of the Theory of Isostasy in India. By Major H. L. Crosthwait. Pp. iii+14+map. (Dehra Dun: Trigonometrical Survey of India.)

Biomechanik und Biogenesis. By Prof. M. Benedikt. Pp. iii+88. (Jena: G. Fischer.) 2 marks.

Richtlinien des Entwicklungs- und Vererbungsproblems. By Dr. A. Greil. Zweiter Teil. Pp. iii+364. (Jena: G. Fischer.) 10 marks.

Junior Sound and Light. By Drs. R. W. Stewart and J. Satterly. Pp. 227. (London: W. B. Clive.) 2s. 6d.

The Marine Mammals in the Anatomical Museum of the University of Edinburgh. By Sir W. Turner. Pp. xv+207. (London: Macmillan and Co., Ltd.) 6s. net.

Narrative of the Visit to India of their Majesties King George V. and Queen Mary, and of the Coronation Durbar held at Delhi, December 12, 1911. By the Hon. J. Fortescue. Pp. viii+324. (London: Macmillan and Co., Ltd.) 10s. 6d. net.

The Theory of Light. By the late Prof. T. Preston. Fourth edition. Edited by Prof. W. E. Thrift. Pp. xxiii+618. (London: Macmillan and Co., Ltd.) 15s. net.

Education and National Life. By Dr. H. Dyer. Pp. 112. (London: Blackie and Son, Ltd.) 1s. net.

Vibration and Life. By Dr. D. T. Smith. Pp. 178. (Boston: R. G. Badger.) 1.50 dollars net.

The Composition of the Atmosphere: with Special Reference to its Oxygen Content. By F. G. Benedict. Pp. iii+115. (Washington: Carnegie Institution.)

A Bicycle Ergometer with an Electric Brake. By F. G. Benedict and W. G. Cady. Pp. iii+44. (Washington: Carnegie Institution.)

The Production of Elliptic Interferences in Relation to Interferometry. By C. Barus. Part ii. Pp. vi+79–168. (Washington: Carnegie Institution.)

CONTENTS.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

No. 2242, Vol. 90] THURSDAY, OCTOBER 17, 1912 [Price Sixpence

Registered as a Newspaper at the General Post Office.]

THURSDAY, OCTOBER 17, 1912.

NATURE IN ROMAN LITERATURE.

The Love of Nature among the Romans during the Later Decades of the Republic and the First Century of the Empire. By Sir A. Geikie, K.C.B., F.R.S. Pp. xi + 394. (London: John Murray, 1912.) Price 9*s.* net.

THIS is indeed a delightful book, full of contagious zest and charm. The love of nature, the love of science, the love of the best literature both of the past and the present, all combine to make it so. It represents the happy adventure of one of our very foremost men of science, the President of the Royal Society, and the *doyen* of British geology, into the realm of classical scholarship and Roman literature. The "classics," as they are commonly called among those who love them and write about them, suffer too often by being made a business of. The affection of the schoolmaster or the classical professor is discounted as being professional, and its sincerity is a little doubted. It is only when some old statesman or soldier, some lawyer or physician, some original modern poet who has made his own name, after experience of the world, turns again, as Cardinal Newman in the famous passage in the Grammar of Assent describes him doing, to the Homer or Horace of his schoolboy hours, that we feel that the classics are being taken at their real value and that their natural undying charm is once more powerfully vindicated.

Specially is this the case when their beauty is avowed, *quod minime reris,* by a man of science. But, indeed, there should be no feud between the love of natural knowledge and of literary art, and, above all, of poetry, the best of which rests so much upon the close observation and faithful presentment of nature. There used not to be such a feud. It may be hoped that we are returning to a more healthy condition both of science and of scholarship when a book such as this comes into being. What were its occasion and origin Sir Archibald Geikie tells us in his modest, pleasant preface. He was asked by the Classical Association to become their president, and he chose, he tells us, for his address a subject which "seemed in some measure to combine the classical interests of the members with his own deep love of nature." This book is the expansion of the address which he then gave—an address which came, perhaps, as somewhat of a surprise to some, but not to those who knew Sir Archibald well or who remembered his Romanes Lecture at Oxford, or his book on "Landscape in History."

Such readers will not be surprised to hear that this new volume is excellently written. The great masters of science have usually written well, but this is more than well written. It is eminently readable, in a style at once lucid and sustained, and sympathetic with its subject. Indeed, it might be used to point the moral that an acquaintance with the masterpieces of antiquity is not without its uses to the modern student or exponent of science.

What may surprise, is that the President of the Royal Society should prove himself so well informed a scholar and, to use the classical phrase, so "ripe" a scholar. For not only is he well "posted up," not only has he read his monographs, his Pelham on the Italian *pascua,* or his Boissier's "Varron"—a rare book—but, still more, to the accuracy and completeness which his science might teach him, he adds a judgment, tact, and taste, pre-eminently considered, mellow, and mature.

It may be noted that he has for the most part translated himself, and often into verse, the many quotations which he makes from the Latin poets. This is a bold course, but justified both by the general good level of the renderings, and still more because it secures two advantages, the first, that of exactness of understanding for the writer himself; the second, that of consistency of presentment for his readers.

The volume, then, is essentially a "humane" book. It is written with real feeling and *con amore.* Geology, notwithstanding its "stony names," of which Tennyson made such ingenious poetic use,

> Of shale and hornblende, rag and trap and tuff,
> Amygdaloid and trachyte,

is really a humane study, for it deals with the structure of the dwelling in which we live, the history and character of the home of our race so far back as we can trace its chronicle.

When Sir Archibald looks at the literature, the poetry, the mode of life, the tastes of the Romans with the "modern eye," the scientific eye, he naturally first sees Italy as a geologist, and, so doing, throws a new light on the figures and epithets, the descriptions and the criticisms, with which the scholar is so familiar.

Italy, the Italy of Cicero and Virgil, the

> Magna parens frugum, Saturnia tellus
> Magna virum,

was always, in the broad geological and geographical sense, the Italy she is now; her kindly and temperate skies with their *indulgentia caeli*; her double sea, largely the secret of her skies; her northern wall and spinal chain of mountains; her lakes; her short rivers, here torrent, here stagnant, now in "spate," now parched threads, the consequence of these mountains; her volcanic energies, slumbering or active—these have always been the same. They make the *mise-en-scène*; they give the colour and the form to the pictures which her poets have drawn in all ages. They are the eternal factors on which the tillers of her soil, the cultivators of her woodlands, have counted, and with which they have contended, from age to age.

The Romans and the ancient Italians were a race of "country men" and "country gentlemen." The rich and fashionable loved to go to "town" for the season. The poorer, when they could get so far, loved more and more the excitement of the city shows and spectacles too, but there were many among both who also loved the country, and not a few who, especially in middle and later life, loved the country more. Like Burke at Beaconsfield or Warren Hastings at Daylesford, like Gladstone at Hawarden or Disraeli at Hughenden, Cicero and Hortensius enjoyed, even if they kept one eye ever on Rome, the refreshment of their *villegiatura*. Horace, though for a time, like Browning, a lover of society, a dandy, and a diner-out, yet more and more came to prefer his Sabine farm. Virgil, like Tennyson, made rare and shy incursions into the metropolis, but like Tennyson again at Farringford or Aldworth, so Virgil at Naples or Nola preferred the *secessus*, the solitude of sea and upland.

Sir Archibald has brought out another resemblance between these two poets, for just as Tennyson never forgot the smallest detail of the "wold" and "marsh" and "table-shore" of Lincolnshire, so Virgil, as he points out, drew from memory, but with astonishing fidelity, the scenery of the northern home he had long left. It is true that in his early poems he introduces, by a sort of *mirage*, the scenery of Theocritus' Sicily, into the plains of Lombardy, but the greater part of his drawing is, as Sir Archibald Geikie points out, "from the life." For Virgil was by birth and nurture a countryman—indeed, a peasant. He was "brought up among orchards and woodlands." He knew the country, and he was a most accurate observer of nature. Sir Archibald Geikie quotes as an instance the famous passage in which he describes the wave rushing up, breaking in foam, flooding the sandy coves, then retreating, at first dragging the spinning pebbles with it, then finally thinning out, as it retires, into a sliding, shallow tide—"picturing," as he says, "in four pregnant words, one of the great dynamical processes of the sea." "Virgil," he adds, "knew nothing of the scientific meaning of the facts he noted, but no man of science could have observed them more accurately or described them with more concise precision." He dwells, too, on the appeal to another sense, the ear: the representation by an alliteration of rough "r's"—"*nunc rapidus retro atque aestu revoluta resorbens*," of what Tennyson, as he recalls, describes as "the scream of the maddened beach dragged down by the wave."

Sir Archibald Geikie doubts whether Virgil had seen the Lake of Como. He thinks that he probably knew the Lake of Garda, from which his own Mincius takes its course. Another scientific poet and lover of nature had no doubt. No one who has read it will forget the passage in which Goethe describes how, at the beginning of his "Italian Journey," he came to the shores of Garda; how he found the south wind blowing up the lake, lashing it into loud and dangerous waves; and how, as he waited and listened to their murmur, he realised after eighteen centuries the fidelity of Virgil's line:—

Fluctibus et fremitu assurgens Benace marino.

The truth is, Virgil was a great "naturalist," and must always furnish the greater part of the material for any writer who tries to estimate the Roman appreciation of nature. That he does so for Sir Archibald Geikie, a glance at the index will show. One of the best passages in the volume is a page of eloquent, if condensed, prose summing up Virgil's love of woods and woodlands. But Virgil was something more than an observer. He was by education not a little of a philosopher also. It is here that he joins hands with Lucretius, whom Sir Archibald Geikie calls a philosopher and man of science, and of whom he says:—

"Among all the poets of ancient or modern times he stands out as the one who may perhaps most fittingly be called the poet of nature."

If Virgil sprang from a peasant stock, Lucretius was of a noble family. His vivid pictures of the *blasé* Roman noble ordering his smart team of "jennets" and tearing from Rome to his place in the country, and then as rapidly back again, is drawn from habits with which he was familiar. But he himself, as these pages remind us, loved the country, mountain, sea and shore, and was in particular specially fond of animals. He loved still more the scientific speculations which these sights, or the contemplation of sun and moon, or the "wide and starry sky," suggest to the thoughtful student. His science he derived, like all Romans, from Greece.

It is not part of Sir Archibald's scheme to include the "love and knowledge of nature among the Greeks," except in so far as this is implied and contained in Roman thought and writing. That measure is, of course, a large one. The Alexandrines in particular, only partly Greek, and living and learning in cities and university towns, amid libraries and observatories, first developed the modern love alike of nature and of natural science. From them it passed to Rome. Aratus, the poet and fellow-countryman whom St. Paul quoted at Athens, was one of the most popular poets at Rome, and influenced, as the President of the Royal Society points out, Cicero and Virgil; he might have added, through Cicero, Lucretius also. Both Lucretius and Virgil, however, owed more still to the prevailing Epicureanism, which from the Greek schools of their time passed over to and permeated Italy. Catullus and Horace and Ovid fell under the same Greek influences.

But this is not the true, genuine native Roman love of nature. That love, a more superficial yet in some ways more natural and pleasing thing, is, as these pages show, to be found in almost all the poets from Catullus to Statius and Martial, in the prose-writers from Varro to Seneca. Its varied expressions and manifestations constitute a rich and copious subject, but Sir Archibald deals with this very skilfully by arranging it under different headings: the love of flowers; the love of animals; Roman gardens; flowers and foliage in Roman art; day and night; the seasons; springs, rivers, and lakes; mountains; the sea-shores; and so on. The result is that he is never tedious. The reader can take up any chapter and almost any page separately, and find something to interest him—the character of the melancholy, amorous Propertius, asking to be "put among the girls"; the clever, frivolous, querulous Ovid; the intense, direct Catullus; the pretentious and somewhat hypocritical Seneca; the importance and the character, almost personal in its significance, of winds and stars to the ancient farmer and seaman; the testimony of the Pompeiian wall-frescoes, half foreign, half local and native, their figures Greek, their landscapes Latin—each is touched in succession with a fresh eye and firm hand.

Incidentally, also, as might be expected, there are references to modern writers—not only to Tennyson, already alluded to, but to Spenser and Shakespeare, to Cowley and Cowper, to Coleridge and Keats, and, of course, to Wordsworth. Perhaps one of the most striking points which is made in these pages, is that the ancients too possessed that

> "inner eye
> Which is the bliss of solitude."

Indeed, the Romans had the very expression, for does not Ovid in his "Metamorphoses," as Sir Archibald Geikie points out, write:—

> Quae natura negabat
> Visibus humanis, oculis ea pectoris hausit?

To conclude, the theme is one which has been touched before, notably by Prof. W. R. Hardie in "Lectures on Classical Subjects," published about a dozen years ago, but never has it been handled so thoroughly or with more freshness and suggestiveness than by the President of the Royal Society in this volume, which we confidently commend to scholars and men of science, but still more confidently to the general reader.

T. Herbert Warren.

PHYSICS—POPULAR AND APPLIED.

(1) *Matter and Energy.* By F. Soddy, F.R.S. Pp. 256. (London: Williams and Norgate; New York: Henry Holt and Co., n.d.) Price 1*s.* net. (Home University Library of Modern Knowledge.)

(2) *Practical Exercises in Physiological Optics.* By Dr. G. J. Burch, F.R.S. Pp. 164. (Oxford: Clarendon Press, 1912.) Price 4*s.* net.

(3) *The Energy System of Matter.* A Deduction from Terrestrial Energy Phenomena. By James Weir. Pp. ix+200. (London: Longmans, Green and Co., 1912.) Price 6*s.* net.

(4) *The Cinematograph and Natural Science.* The Achievements and Possibilities of Cinematography as an Aid to Scientific Research. By L. Donaldson. Pp. 88. (London: Ganes, Ltd., 85, Shaftesbury Avenue, W., 1912.) Price 2*s.* 6*d.* net.

(5) *Oscillations et Vibrations.* Étude générale des Mouvements Vibratoires. By A. Boutaric. Pp. ix+403. (Paris: Octave Doin et Fils, 1912.) Price 5 francs. (Encyclopédie Scientifique.)

(6) *Physik.* Zum Gebrauch bei physikalischen Vorlesungen in höheren Lehranstalten sowie zum Selbstunterricht. By Prof. H. Böttger. Erster Band: "Mechanik, Wärmelehre, Akustik." Pp. xiii+983. ("Das Buch der Natur," Dreiundzwanzigste Auflage. Dritter Teil, Zweite Abt.) (Braunschweig: F. Vieweg und Sohn, 1912.) Price 15 marks.

(1) IT is always difficult for the reviewer of a book who naturally possesses a more or less intimate knowledge of the subject under review to write with confidence concerning a popular treatise. There is always the possibility that his previous knowledge enables him to appreciate many points which may not be so easily grasped by others less acquainted with the sub-

ject. And, after all, it is for this latter class that such books are primarily intended. But in the present case there is scarcely room for doubt that Prof. Soddy has successfully accomplished the very difficult task of making physics of absorbing interest on popular lines. This has been done without any of that sacrifice of exactness of statement which so often mars works of this kind; thus the trained physicist and the novice may read the book with equal pleasure. It is quite surprising how many phenomena the author has been able to deal with in this fashion, and what up-to date work he has been able to introduce. There is no space available to detail the various contents more than to say that such subjects as the kinetic theory of matter (including reference to Perrin's beautiful experiments on Brownian movements) and radioactivity, among others, are treated with admirable lucidity. A book of this kind deserves a longer review; it is to be hoped it will have a large circulation, for it forms a worthy addition to the excellent series to which it belongs.

(2) This consists of a series of descriptions of experiments which Prof. Burch has compiled, based upon the work of practical classes in the Physiological Laboratory, Oxford. About sixty experiments are described, dealing with the dioptrics of the eye, judgments of the eye, sensations of the eye, the measurement of colour sensations, and experiments with flashing light.

(3) From time to time during the progress of physical science a book appears the author of which is thoroughly dissatisfied with everything that has been accomplished, and desires to begin again on an entirely new foundation. This book is the latest of the kind. The author, in this case, claims to have made an intimate study of natural phenomena, and to possess a lengthened experience in physical research. Such a claim is, however, scarcely borne out by a perusal of his book. One cannot help thinking that his dissatisfaction with things in general arises rather from his own lack of acquaintance with the exact nature of physical science than from any fundamental error in present-day theories. It is really impossible to take the book seriously; at any rate, the present writer finds it so.

(4) This is a little book dealing with various applications of the kinematograph to scientific research. The author directs attention to what has already been achieved, and throws out suggestions as to the lines upon which further progress could be made.

(5) This is a treatise of a rather advanced character, though very much compressed, upon wave-motion, &c., particularly in its applications to sound and light. It is rather poorly printed, and the diagrams are not well produced.

(6) Like many similar German text-books of physics, the treatment in this one is very full—surprisingly so when it is remembered that it is intended for use in schools. This is the first volume, and comprises mechanics, heat, and sound. The type and diagrams are good.

MICRO-ORGANISMS AND THE HOMESTEAD.

(1) *Microbiology for Agricultural and Domestic Science Students.* Edited by Prof. C. E. Marshall. Pp. xxi+724. (London: J. and A. Churchill, 1912.) Price 10*s*. 6*d*. net.

(2) *Microbes and Toxins.* By Dr. E. Burnet. With a preface by Elie Metchnikoff. Translated from the French by Dr. C. Broquet and Dr. W. M. Scott. Pp. xvi+316. (London: William Heinemann, 1912.) Price 5*s*. net.

(3) *Bacteria as Friends and Foes of the Dairy Farmer.* By Wilfrid Sadler. Pp. xv+112. (London: Methuen and Co., Ltd., 1912.) Price 1*s*. 6*d*.

(1) MICRO-ORGANISMS are of far-reaching importance in agriculture, and the domestic science student cannot afford to neglect them, and the appearance of a work dealing with these branches of bacteriology, particularly the latter, is therefore opportune.

A number of well-known authors, specialists for the most part in their various subjects, have collaborated to produce the book under review. The editor, Prof. Marshall, fully recognises the weakness of this system of compilation, and has attempted, with success we think, to coordinate the whole. He points out that the term "bacteriology" has come to include many groups of micro-organisms other than the true bacteria, and the term "microbiology" has therefore been employed as a title for the present book.

The scheme of the book is comprehensive and well conceived, and ranges over a wide field. The subject-matter is divided into three parts: the first deals with the morphology and culture of micro-organisms, including the Protozoa; the second with the physiology of micro-organisms; and the third with applied microbiology. The last includes sections on air, water and sewage, the soil, milk and milk products, the preservation of foods, alcohol, vinegar and other fermentation products, and the microbial diseases of plants, man, and animals. We have found practically nothing in the contents to criticise, and the book is well illustrated with 128 figures in the text and one coloured plate of the malaria parasite.

(2) This book fills a lacuna in bacteriological

literature, inasmuch as it deals with the general physiology and functions of micro-organisms. While appealing more particularly to the specialist, the general reader who has some biological training and desires to obtain a general survey of the activities of micro-organisms may peruse it with advantage. The third chapter, which deals with the form and structure of microbes, contains a brief but sufficient account of recent work on these subjects, and the section on reproduction and sexual reproduction of these lowly organisms is particularly good. The chapters on infection, immunity, and supersensitivation are models of judicious selection from the voluminous literature, and give excellent summaries of the subjects.

The author, being a member of the staff of the Pasteur Institute, naturally gives considerable prominence to the views of the French school on the physico-chemical nature of the toxin-antitoxin reaction, but the other hypotheses are fully and fairly stated. Final chapters deal with the applications of bacteriology, vaccines, and curative sera and chemio-therapy. We demur to the statement (twice repeated) that because an animal's serum may naturally possess some antitoxic power towards diphtheria or tetanus toxin, such an animal *must* therefore have harboured the diphtheria or tetanus bacillus. Though this may be the explanation in some cases, we do not think that it is necessary to postulate such an infection in all instances. If antitoxin be generated during artificial immunisation by the detachment of *natural* side-chains from cell-protoplasm, there is apparently no reason why similar side-chains should not *normally* become detached by ordinary physiological processes, constituting the small amount of antitoxin sometimes found in a non-immunised animal.

We have read this book with much interest, and can recommend it as giving an excellent account of the subjects of which it treats.

(3) As Mr. Golding says in the introduction to this little book, "it has become an absolute necessity that the dairy farmer should be acquainted with some knowledge of the world of microscopic beings with which he is beset on all sides, and be able to distinguish his friends from his foes among this host which he cannot see, but to which he owes, and from which he fears, so much." We think that this book will well supply this kind of knowledge to the producer, the purveyor, and the consumer of milk. After a simple introductory statement of what bacteria are and how they grow and multiply, the use of starters for butter- and cheese-making is considered. The production of a pure milk is then discussed, and the sources and nature of contamination are described, the cow and milking, transit, distribution, and consumption of milk all being considered. A few pages are devoted to disease germs and the sour-milk treatment, and the book concludes with a short bibliography for the use of those who desire further information on the subject.

R. T. HEWLETT.

OUR BOOKSHELF.

Nature Photography. What to Photograph, Where to Search for Objects, How to Photograph Them. By Stanley C. Johnson, M.A. Pp. 115. (London: Hazell, Watson and Viney, Ltd., 1912.) Price 1s. net.

"NATURE" is a very wide term. It is not possible to state concisely the meaning that the author attaches to it. He does not refer to the larger animals, and though he gets down to beetles and butterflies, he does not include the smaller creatures that are generally called microscopic. He deals with fishes, birds, flowers, trees, reptiles and some of the larger insects, giving what is evidently his own experience in connection with the photography of such things. This personal character of the book gives it a value that a more inclusive compilation might not possess. He has very little to say about the actual photography, but treats rather of the selection and arrangement of the subjects, where and when to look for them, and so on, and in this connection gives advice that will be found of great value by those who do work of this kind.

In dealing with the bright colours and delicate shades that some of these objects present, the author's practice of using only stained plates ("non-filter," as they are called) cannot be regarded as thoroughly sound. His own illustrations of coloured objects are not good, but it is possible that the chief fault here lies with the maker of the blocks. The truthful rendering of various colours in monochrome is now fairly well understood by those who care to study the matter, and is not to be dismissed in a line or two by the simple recommendation to use any particular plate.

Dactylography, or the Study of Finger-prints. By Henry Faulds. Pp. 127. (Halifax: Milner and Company, n.d.) Price 1s. net.

THIS little book is the latest addition to the "Twentieth Century Science Series," which includes volumes that treat scientific subjects in a popular manner for the general reader. Mr. Faulds here writes in an interesting way on a subject with which his name has long been associated as an authority, and the reader is provided with a trustworthy account of the technique of printing and scrutinising finger-patterns and of classifying them. The practical results which followed the study of finger-prints are enumerated, and the future prospects of the subject outlined.

The Transactions of the American Institute of Chemical Engineers. Vol. iv., 1911. Pp. iv + 514. (New York: D. Van Nostrand and Co.; London: E. and F. N. Spon, Ltd., 1912.) Price 30s. net.

Two addresses delivered by the president, Dr. F. W. Frerichs, at Chicago and Washington are chiefly devoted to descriptions of six problems in chemical engineering practice. One of these, the extraction of bismuth from carbonaceous ores, consists of a complete account of the recovery of this metal from ores containing 1 oz. of lead, 15 oz. of silver 5 per cent. lead, and 5 per cent. of bismuth. The metal can be produced greatly in excess of the consumption, which in 1910 was about 200,000 lb for the United States. It is used almost exclusively for medicinal purposes.

Mr. Clarence Hall, explosives engineer, United States Bureau of Mines, contributes an interesting paper on explosives used in engineering and mining operations. The apparatus used at the Pittsburg testing station for the determination of the relative energy and efficiency of various explosives, such as black powder, granulated nitroglycerine powders, and nitro-glycerine and ammonia dynamites, is described. Mettegang's recorder for determining the rate of detonation is used, and velocities of detonation up to 6240 metres per second have been found for 60 per cent. nitroglycerine dynamites. The recorder has a soot-covered bronze drum 500 mm. in circumference which can be driven up to 105 revolutions per second, and marks are made thereon by electrical contact devices.

The manufacture of gelatine is described by Mr. Ludwig A. Thiele. The raw materials are bones, from which osseine is derived, and hidestock. The process is the same for the osseine and hidestock, the former being got from the bones by treatment with either hydrochloric, phosphoric, or sulphurous acid, during which process a valuable by-product, acid phosphate, is produced. A report of the Committee on Chemical Engineering Education is included in the volume, together with other papers on manufacturing processes.

Science French Course. By C. W. Paget Moffatt. Pp. x + 305. (London: W. B. Clive, University Tutorial Press, Ltd., 1912.) Price 3s. 6d.

THE object of this book is, the author says, to provide students of science who desire to read French scientific literature with the necessary minimum of French grammar, and a selection of extracts from which some practice may be obtained. For students with no knowledge of French at all the amount of assistance given in translation appears rather inadequate, but for those who have forgotten what was learnt at school and wish to revise rapidly, the book should prove of great assistance. The extracts will form excellent reading in French for boys and girls in the upper forms of secondary schools who are taking a course of work in science.

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.]*

The Synthesis of Matter.

IN the issue of NATURE for July 18 last, there appears an important letter from Sir William Ramsay dealing with the appearance of hydrogen, helium, and neon in the glass of exhausted X-ray bulbs. This result is of great interest, and may have an important bearing in addition to that mentioned by the author.

It is well known that X-ray bulbs only possess a limited period of life and go "soft," as it is termed, as if a small amount of gas previously adsorbed by the glass had been set free. The thought occurred to me some time ago that the softening might not be due to this cause, but to rare gases, such as helium, actinium, &c., produced from the æther of the vacuum becoming charged with energy from the kathode. It is such gases which are found in the process known as inorganic evolution in the hottest stars and nebulæ, and discovered there first by Lockyer, before their terrestrial occurrence in cleveite and elsewhere was detected by Ramsay.

If elements can decompose with evolution of energy as in radio-activity, it would seem not impossible that matter might be synthetised with absorption of energy, and that a first stage in such a process might be the formation of electrons by the charging of æther with a permanent form of energy, followed by a synthesis of ordinary matter in which such gases as helium would be a first product.

Attempts were made by me at the time to obtain evidences of helium from exhausted X-ray bulbs, but failed, as I now believe, from the small quantity of gas available and my lack of training in this very specialised field of manipulation. It would be interesting to carry out a prolonged experiment with an X-ray bulb run for days, and pumped out at intervals, in order to ascertain whether such development of helium took place.

It is, of course, possible that any gas so arising might come from the electrodes and glass undergoing atomic disintegration, but the possible origin of matter from æther when there is an available supply of energy at high potential should not be lost sight of. Theory suggests that such a formation is possible, if matter consists of vortex rings or other permanent forms of periodic movement of the æther, and it may be that in the chromosphere spectra there is evidence of production of matter occurring at the present time.

BENJAMIN MOORE.

The Bio-Chemical Department, the University, Liverpool, October 9.

The Jaw from the Stalagmite in Kent's Cavern.

I AM much obliged to Prof. Keith for his reply to my letter on the Kent's Cavern jaw, from the granular stalagmite. As my friend Prof. Boyd Dawkins, who read the paper, was a member of the Kent's Cavern Committee, and reported in 1869 on the fossils found up to that date, I naturally took for granted that all the facts of the case would be before Section H, and that Prof. Keith was challenging the evidence.

On referring to Prof. Boyd Dawkins's 1869 report I noted with surprise that the jaw was not even mentioned. To those acquainted with the history of Kent's Cavern this omission is easily explained.

Throughout the explorations of the cavern, beginning in 1825, all the evidence in favour of the antiquity of man was challenged and explained away by outside critics. Objects in and under the stalagmite were accounted for in one of the following ways, viz.: (1) interments; (2) cracks or fissures; (3) the stalagmite was a comparatively recent invading magma!

For these reasons it would have been unwise, in 1869, to depend on any evidence so certain to be challenged. Indeed, the value of the evidence of the said jaw has not been publicly discussed up to the present time.

After Pengelly's death Sir John Evans published the second edition of his "Ancient Stone Implements," in which, alas! he seems to have followed the earliest explorers in the general assumption of fissures. Sir John observes that in the stalagmite there were few remains, "whether human or otherwise, and these for the most part may have fallen in from higher levels." He further observes that "concerning this long chapter in the history of human existence the records of the cavern are a blank." If I may venture to say so, the distinguished archæologist must have compiled his account of Kent's Cavern from early and late records as of equal authority.

So far as the weighty authority of the chairman of the Kent's Cavern Committee (but not on the committee when the jaw was discovered) is concerned, Prof. Keith would be fully justified in questioning the authenticity of the jaw in question.

In Pengelly's Glasgow lecture (1875) we find the words—"I have found teeth of the mammoth, teeth of the woolly rhinoceros, teeth of the cave hyæna, and teeth of the cave bear in the very uppermost part of the stalagmite; and a human jaw, with four teeth in it, at the base of the same deposit" (pp. 17–18).

In describing a bone pin found under the stalagmite, near the same spot as the jaw was found, Pengelly incidentally describes the stalagmite as "20 inches thick, perfectly intact, and *continuous in all directions*" (Report Brit. Assoc., 1867, p. 31). The italics are mine.

One item of evidence *per contra* must be noticed, viz. that "one of the artificially formed flints [from the stalagmite] has the appearance of being a fragment of a polished Celt or axe, and is the only specimen of the kind which has been found in the cavern." Nothing of the sort, we are told, was subsequently found.

It is much to be regretted that the British Association did not complete its sixteen years' exploration with a general summary of results, with plans and sections. There is, I believe, no general ground plan of the cavern in existence, except the rough sketch which I prepared for the last visit of the Geologists' Association (Proc. Geol. Assoc., vol. xvi., p. 437, 1900).

A. R. Hunt.

Torquay, October 7.

A Pearl from Nautilus.

The accompanying photograph shows a pearl (natural size), alleged to have been found in *Nautilus pompilus*, from the Sulu archipelago. It was lent to me for examination by Mr. T. H. Haynes, of the Montebello Islands, north-west Australia, one of the pioneers of the pearl-shelling industry in Australia and the East Indies, who is now in England. This pearl was given to Mr. Haynes, about 1884, by a half-breed Chinaman named Oto, brother-in-law to the late Sultan of Sulu, Mohamed Budderuddin.

Mr. Haynes tells me that the pearly Nautilus is occasionally taken alive by the pearl-shell divers, by whom the flesh is considered a great delicacy. Now and then a pearl is found in a Nautilus, but as these pearls are considered unlucky they are usually thrown away. There is a superstition among the natives that, if a man fights with a Nautilus pearl in a ring on his finger, he will be killed. It is probable, therefore, that few, if any, examples of these Nautilus pearls have found their way into the West.

A Nautilus pearl. Natural size.

The pearl, which is a perfect pear-shape, slightly flattened at the broader end, weighs 18 carats (72 grains), and is composed of the porcellanous (not the nacreous) constituent of the shell. It is somewhat translucent, white, with a slightly creamy tinge, rather suggesting fine Beleek china. The broad end, which has apparently been flattened by pressure of the shell upon the pearl sac, is rather more transparent and vitreous.

H. Lyster Jameson.

Royal Colonial Institute, London, W.C.

Errors of the Computed Times of Solar Eclipse Phenomena.

With regard to Dr. Downing's letter on this matter (Nature, October 10, 1912), may I be allowed to remark that I was fully aware of his warning that the computed eclipse times of second and third contacts were too late. In fact, I carried with me to Vavau the reprint of his paper to which he alludes (Monthly Notices R.A.S., vol. lxix., p. 31), which he had kindly sent me, and frequently consulted it. In addition, I had prepared an instrument for projection of the solar image so as to observe the angles of cusps given in his paper, but as Dr. Lockyer also had a similar instrument, we arranged that I should make use of his time signals.

As a further precaution, to obtain the time of the first flash, I had arranged a direct-vision spectroscope adjusted on the C line in the chromosphere at the angle of second contact. Unfortunately, the clouds at the time of second contact rendered all these precautions useless.

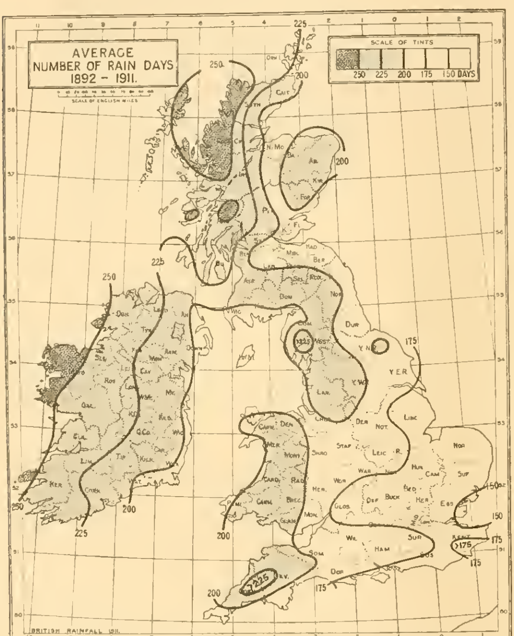
I trust that Dr. Downing does not read into my remark, "The total phase commenced about 20 seconds before the predicted time" (Proceedings R.S., No. A595), anything more than a mere statement of a fact.

A. L. Cortie.

Stonyhurst College Observatory, October 14.

BRITISH RAINFALL IN 1911.

THE Director of the British Rainfall Organisation is to be congratulated on the volume he has produced[1] dealing with the rainfall of the British Isles, and for the compilation of which he has the assistance of 5300 observers. As time goes on the value of the work undertaken is greatly enhanced, not only by the extension of the observations and the greater accuracy of the results, but also by the completeness of the discussions rendered possible by the accumulation of data. The thoroughness with which the work is carried out both by the voluntary observers and by Dr. Mill and his assistants merits the greatest admiration, and is a masterpiece as a private undertaking.



A discussion of the distribution of rainfall in time is given which will prove of very great value, and is a matter of considerable interest even to the general public endowed merely with average scientific craving.

In a former volume for 1902, a first attempt was made in the same direction, dealing only with the observations for ten years, and these embracing chiefly a dry period. Now a period of twenty years, 1892 to 1911, is dealt with, and the results at 100 stations of established accuracy have been collated, which may with some confidence be expected to furnish a trustworthy average.

There is naturally a relation existing between the frequency and amount of rainfall, the wetter western districts showing a greater frequency than the relatively drier Eastern districts.

The rain days for the year on the average of twenty years range from 250 in the north-west of Scotland and the west of Ireland to 150 in the estuary of the Thames; and England, with the exception of the north-western and western districts, has fewer than 200 rain days in the year.

The map of frequency, like that of quantity, suggests very clearly the controlling influence of the westerly winds which predominate, and which are laden with moisture from off the Atlantic on their arrival over the British Isles.

The abnormal year of 1911 was believed to have been unparalleled for its dry periods, and under the heading of "Droughts in 1911" a comparison is made between the results for 1911 and the records of the last twenty-four years, selecting one hundred well-distributed stations in the British Isles; this shows that the surmise about 1911 is not without foundation. 1911 had more absolute droughts than any other year except 1887, and it had the largest number of partial droughts. An absolute drought is no rain for more than fourteen consecutive days, and a partial drought a period of more than twenty-eight consecutive days with a mean rainfall not exceeding 0·01 in. per day. The absolute droughts in 1911 were more than double the average, and partial droughts little short of three times the average.

Dealing with heavy rains in short periods, an exceedingly interesting table is given showing the rainfalls of very rare intensity lasting for one hour or less. The heaviest authenticated measurement is 0·33 in. in two minutes, which is equal to the hourly rate of 9·90 in. at Chepstow in March, 1888, and this is followed by 0·50 in. in four minutes, which is equivalent to 7·50 in. per hour, at Ilkley in June, 1906. A reported fall of 1·25 in. in five minutes at Preston in August, 1893, which gives a rate of 15 in. per hour, is accepted with caution. At Beddington, in May, 1903, a fall of 3·50 in. occurred in an hour. This table is of considerable value, as it affords means of comparison for such extraordinary rains as have recently occurred in Norfolk, where at Norwich, between noon and 1 p.m., September 26, the rainfall amounted to 1·15 in., and to 7·32 in. in twenty-four hours ending 4 a.m., September 27.

C. H.

[1] "British Rainfall, 1911." On the Distribution of Rain in Space and Time over the British Isles during the Year 1911, as recorded by more than [illegible] Observers in Great Britain and Ireland, and discussed with Articles upon various branches of Rainfall Work. By Dr. H. R. Mill. The Fifty-first Annual Volume. Pp. 108+388. (London: Edward Stanford, Ltd., 1912.) Price [illegible]

THE EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

THE Congress of Applied Chemistry, which met this year in Washington and New York, is the eighth of a series of triennial gatherings held hitherto in centres of chemical activity in the Old World, the last three meetings having taken place in London, Rome and Berlin.

The onerous task of preparing for the reception of the eighth congress was commenced three years ago by an influential committee of American chemists, Prof. E. W. Morley and Dr. W. H. Nichols being nominated honorary president and president respectively, with Dr. Bernhard C. Hesse as secretary. The interesting programme drawn up by this committee attracted a large number of European chemists, chiefly from Germany, and about thirty nationalities were represented by official delegates. Among the eminent chemists attending the meeting were three past-presidents of former congresses—Prof. L. Lindet (Paris), Sir William Ramsay (London) and Prof. F. Strohmer (Vienna). Prof. P. Walden, president-elect of the next congress (St. Petersburg), was also present.

The scientific work of the congress was divided into twenty-four sections, and one very noteworthy feature, which distinguished this meeting from its predecessors, was the rapid printing of the proceedings in twenty-four volumes, containing nearly 600 accepted papers, these being ready for distribution to the members at the opening of the meeting on September 3. The discussions taking place in the various sections were recorded phonographically by a special phonograph devised for this purpose by Mr. Edison.

The congress was opened formally at Washington, in the Memorial Continental Hall, on September 4, and the delegates and members were welcomed by His Excellency President Taft, at the White House. Several Government institutions established at Washington were visited by the members, special attention being devoted to the laboratories of the Department of Agriculture, the Bureau of Standards, the Geophysical Laboratory and the U.S. Geological Survey. The scientific work of the sections was carried on in New York from September 6 till September 13, the meetings being held in the lecture-rooms placed at the disposal of the congress by the authorities of Columbia University, to whose generous hospitality the congress is indebted both for this suitable and compact group of rooms and also for the use of several residence-halls in which many members were housed during the congress meetings.

In the analytical section were presented several important papers and reports of committees on the standardisation of methods of sampling and analysis. The extraction of potash from felspars and other minerals was discussed in the section of inorganic chemistry, and joint meetings with the sections of metallurgy and mining were held to consider topics of interest in connection with new alloys, among which may be mentioned the combinations of boron with copper and other metals, demonstrated by E. Weintraub. The electric furnace and its applications was the subject of a joint session between the metallurgical and electrochemical sections. The production and properties of Portland cement were debated in the section of silicate industries. In the explosives section stability tests for these materials were discussed by several investigators, and tetranitroaniline was recommended by its discoverer, B. Flurscheim, as a safe explosive with a shattering power only second to that of nitroglycerin.

The section of organic chemistry received the greatest number of papers and was the scene of several animated discussions. The chemical structure of the azoimide nucleus present in organic and metallic azides was dealt with by M. O. Forster. The perennial topic of colour and constitution was discussed in joint session with the section of coal-tar colours, interesting papers on aniline black and quinonoid addition in dyestuff synthesis being contributed by A. G. Green. In the sugar section, reports were presented on uniform methods of sugar analysis by von Buchka, Prinsen-Geerlings, Saillard, Strohmer and Weichmann. A paper on the valuable plastic material "baekelite," the condensation product of phenol and formaldehyde, was read by its discoverer, L. H. Baekeland, before the section of indiarubber and other plastics. A report on the standardisation of methods of determining water in coal and in other fuels and in minerals, drawn up by G. T. Holloway, was presented by R. Lessing to the section on fuels.

Among the large number of important papers contributed to the section of agricultural chemistry may be mentioned a series of communications by G. Bertrand and his collaborators on the catalytic action in fertilisers of small quantities of manganese, boron, zinc and aluminium. The standardisation of disinfectants by the Rideal-Walker test was advocated by S. Rideal in the section of hygiene. The sterilisation of potable water by hypochlorites was the subject of several communications to the same section. An interesting paper on the chemical reactions of micro-organisms was read before the section of biochemistry by F. Ehrlich, and several investigators presented communications bearing on the relationship between chemical constitution and germicidal or physiological action.

The utilisation of American natural gas has led C. Baskerville to study the chlorination of this cheap source of methane, and his results were communicated to a joint meeting of the sections of inorganic chemistry, photochemistry and electrochemistry. To the last of these sections were presented several papers on the electric smelting of iron, zinc and other metals, and on the electrolytic processes of producing chlorine, alkali and hypochlorite.

In the section of political economy and conservation of natural resources reference was made to the conservation of forests and water supplies, and to the utilisation of peat and coal waste.

Another important feature of the work of this congress was the delivery of four lectures of general interest by eminent chemists representing France, Germany, Great Britain and Italy. The great hall of the college of the city of New York, having a seating capacity of 3000 persons, was available for this purpose and for the general meetings of the congress.

Prof. Gabriel Bertrand spoke on the part played in agriculture by the minor constituents of plants. It has been demonstrated that the element manganese, present only in minute quantities in plants, enters into the composition of laccase, an enzyme, first extracted from the lacquer tree, which is capable of bringing about an assimilation of atmospheric nitrogen. Small additions of manganese have been found to increase crops to a considerable extent, and similar effects have been produced with other of the less common elements. These results lead to a new class of fertilisers—the catalytic manures—which are capable of modifying favourably the fertility of the soil.

Dr. Carl Duisberg lectured on the latest achievements and problems of the chemical industry. The problem of the utilisation of peat has received a solution in Frank and Caro's process of producing peat gas for heating purposes with recovery of the nitrogen as ammonia. Great strides have been made in the manufacture of refined steels containing other elements besides iron and carbon. The nickel alloys are of great value; those containing 23 per cent. and upwards of this metal are non-magnetic, whilst the 45 per cent. alloy has a coefficient of expansion not greater than that of glass. Steels containing chromium and molybdenum are remarkably resistant to mineral acids; the alloy containing 60 and 3 per cent. of these metals respectively is not appreciably attacked by boiling aqua regia. Steels containing chromium, tungsten and vanadium have a high degree of hardness. Vanadium steel is employed in forging high-speed tools, and the firm of Krupp have patented a steel which can neither be drilled, nor disintegrated by explosives, nor cut by the oxyhydrogen or oxyacetylene flame. Electrolytic iron, which is now manufactured free from hydrogen by electrolysis in hot solutions, can be magnetised and demagnetised more readily than ordinary iron containing carbon and silicon. Electromotors in which this material is used are two-and-a-half times as efficient as those constituted of silicon iron. The lecturer reviewed the recent developments in colour synthesis, pharmaceutical chemistry and chemotherapy, the treatment of infectious disease with chemical compounds. The production of non-inflammable kinematograph films ("cellite") and non-inflammable celluloid ("cellon") from acetylcellulose are valuable improvements which must eventually promote greater security of life and property from fire.

A controversial topic was reached when the lecturer dealt with the problem of the manufacture of artificial rubber. He asserted that F. Hoffmann, of the Elberfeld factory, is to be regarded as the real discoverer of synthetic rubber, this investigator having polymerised isoprene to rubber in 1909, a discovery which has been followed by the production of certain homologues of natural rubber. This view of the synthesis of rubber was subsequently refuted by Prof. W. H. Perkin in a lecture on the polymerisation of butadiene and isoprene, when reference was made to Tilden's discovery of nearly thirty years ago that isoprene polymerised to a substance identical with natural rubber. Specimens of Tilden's preparations were exhibited, and the lecturer gave an account of recent successful experiments on rubber synthesis starting from amyl alcohol made by a group of English chemists in collaboration with the French bacteriologist Fernbach.

The third general lecture was delivered by Prof. Perkin, who described the experiments which led to the fireproofing of the very inflammable material flannelette with precipitated hydrated stannic oxide, a treatment which renders the fabric ("Non-flam") permanently fireproof without affecting the colour of the dyed cloth, while its strength is increased by 20 per cent.

The fourth general lecture was delivered by Prof. G. Ciamician, who spoke on the photochemistry of the future and advocated the utilisation of radiant solar energy either directly in promoting photochemical change or indirectly by the intensive cultivation of plants yielding industrially valuable products, the harvested plants being subsequently converted economically into gaseous fuel and their mineral ash and recovered nitrogen being restored to the soil.

Closely allied to the subject of intensive cultivation were two addresses dealing with the fixation of atmospheric nitrogen. In the first of these discourses Dr. S. Eyde, who referred to the oxidation of atmospheric nitrogen, described the remarkably rapid growth of the synthetic nitrate industry of Norway and the methods employed in utilising the water-power of that country. In the second address Dr. H. A. Bernthsen gave an outline of Haber's process for synthesising ammonia, now being developed on a manufacturing scale by the Badische Anilin und Soda-Fabrik.

By operating with purified hydrogen and nitrogen under high pressure (200 atmospheres) at 650–700° C. in the presence of a suitable catalyst (iron, manganese, molybdenum, tungsten, uranium carbide, &c.), about 8–10 per cent. of the gaseous mixture is converted into ammonia, which is either separated by liquefaction or dissolved out by water.

In addition to the general lectures and sectional meetings, the social side of the congress was fully developed, and a special entertainment programme was arranged for the ladies accompanying the members and delegates.

At the close of the congress nearly 300 of the members proceeded on one or other of two tours arranged by Drs. Rosengarten and Day and other members of the special transportation and factory inspection committees. Two special trains were provided, and at each stopping-place local committees had been organised, the representatives of which met the visitors and conducted them by rail or motor-car to factories, laboratories and other places of interest. The shorter of these tours took ten days, during which the party visited Philadelphia, Pittsburg, Niagara, Detroit, Chicago, Cleveland and Boston. The longer tour included a journey to the western and southern States, with visits to Salt Lake City, San Francisco, Los Angeles, Grand Canyon, Arizona, New Orleans, Atlanta and Washington.

The small band of British chemists who had the good fortune to attend this congress and take part in the excursions are unanimous in their praises of the splendid organisation and cordial generous hospitality experienced at every stage of their visit. American chemists are to be congratulated not only on a congress of great scientific interest and importance, but also on the unqualified success which invariably attended their praiseworthy efforts to entertain and instruct their guests.

G. T. Morgan.

PREHISTORIC MURAL DECORATIONS IN BACON'S HOLE, SOUTH WALES.

The cave of Paviland (Gower, South Wales), first investigated by Buckland so long ago as 1823, has lately acquired a fresh interest in the light of recent discoveries made in France.

Most of the objects found by Buckland are exhibited in the Oxford University Museum, where they fill the greater part of a case devoted to the Aurignacian age. Among them are cylindrical rods (like lead pencils in size and shape) carved out of mammoth ivory, an ivory lissoir (*i.e.*, smoother), and some other rudely shaped pieces of ivory. Prof. Breuil, the greatest authority on Aurignacian remains, being on a visit to Oxford, made an examination of these objects last week and unhesitatingly referred them all to the Aurignacian age. There are also some fragments of a beautifully worked ivory ring, about the size and shape of an Indian bangle, or a little smaller; these also were assigned with equal confidence to the Aurignacian, precisely similar rings having been found in deposits of this age in France.

As a consequence of these results, Profs. Breuil and Sollas decided to visit the caves of Gower in the hope of finding some painting on the walls. A halt was made on the way at Swansea, in order to examine the rich collection of flint implements from Paviland which are preserved in its museum. These proved unusually interesting, and were for the most part identified by Prof. Breuil as Upper Aurignacian, a few being Proto-Solutrian. A systematic search was then made of the caves, beginning with Paviland, on the west, and working towards Bacon's Hole, on the east; as cave after cave failed to yield any signs of painting, hope began to wane, but, on entering Bacon's Hole, colour was seen on the right-hand wall. Closer examination revealed the presence of ten bright red bands, approximately horizontal or slightly divergent, fan-like, arranged one above the other in a vertical series, about a yard long, each band being perhaps a foot in length and one to two inches in breadth, but no exact measurements were made. The stalactite which has tapestried the wall is very clean and has completely sealed up the red pigment (iron-ochre), so that it cannot be removed by rubbing.

It is of interest to note that similar bands, similarly arranged, but only eight in number, have been observed at the end of the great gallery in the Font de Gaume of Dordogne.

It is to be hoped that a general search will now be made in our English caves for other examples of mural decoration; they may be easily passed over by the casual visitor, and to be seen must be looked for.

NOTES.

As already announced in these columns, a meeting is to be held at the Mansion House at 2.30 p.m. on October 23 to take steps to raise a fund for the establishment of a memorial to the late Lord Lister. Among those who will address the meeting are the Prime Minister, the president of the Royal Society (Sir Archibald Geikie, K.C.B.), the president of the Royal College of Surgeons (Sir Rickman J. Godlee), Lord Avebury, F.R.S., and the Hon. W. F. D. Smith.

The Paris correspondent of *The Times* announces that the international conference on time reckoning was opened at the Observatory on October 15 by M. Guist'hau, Minister of Education; and M. Bigourdan, member of the Institute and of the Bureau des Longitudes, was elected president. The conference has been summoned mainly with the object of dealing with various practical uses of wireless telegraphy in the synchronisation of time signals throughout the world.

Sir George Darwin, who recently underwent an operation, continues to make such good progress toward recovery that no further bulletins will be issued.

The death is announced, at the age of fifty-eight, of Mr. F. H. Low, the honorary secretary of the Röntgen Society. Mr. Low was the medical officer to the X-ray department of the London Medical Graduates' College and Polyclinic.

It is announced, through Reuter's Agency, that the Nobel prize for medicine for 1912 has been awarded to Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research in New York, for his works on the suture of vessels and the transplantation of organs. The prize this year is said to amount to about 7800*l*.

A course of six lectures on the properties and manufacture of concrete is to be given, by Mr. H. Kempton Dyson, secretary of the Concrete Institute, at the Concrete Institute, Denison House, Vauxhall Bridge Road, Westminster, at 5.30 p.m. on Tuesdays, beginning on November 12. The lectures are free, and tickets of admission may be obtained from the secretary of the institute.

A memorial service for the late Mr. H. O. Jones, F.R.S., fellow of Clare College, Cambridge, demonstrator to the Jacksonian professor of natural experimental philosophy, and Muriel Gwendolen Jones, his wife, who were killed in the Alps in August while on honeymoon, was held at the University Church of St. Mary the Great, Cambridge, on October 12. The service was attended by a large congregation, which included masters of several colleges, University professors, and many other members of the University. The Royal Society, the Alpine Club, and the Cambridge Alpine Club were also represented.

The council of the Institution of Civil Engineers has made the following further awards for papers read during the session 1911–12:—A Watt gold medal to Prof. W. H. Burr (New York), and the Crampton prize to Prof. R. J. Durley (Montreal). The following Telford premiums have also been awarded for papers published in the Proceedings without discussion during the same session:—To Messrs. Paul Seurot (New York), David Anderson, and Harry Cunningham (London), Dr. S. P. Smith (Birmingham), Mr. E. G. Rivers (Richmond), Mr. E. H. Morris (Manchester), and Prof. A. H. Gibson (Dundee). The Howard quinquennial prize for 1912 has been awarded to Mr. J. H. Darby (Sheffield), in recognition of improvements introduced by him in iron and steel production, and the Indian premium for 1912 to Mr. H. H. G. Mitchell (Madras).

The nineteenth report of the Museum and Art Gallery Committee to the Town Council of the borough of Leicester deals with the period from April 1, 1910, to March 31, 1912, and provides an interesting description of two years' excellent work and progress. In addition to the Saturday evening public lectures, which have long been a successful part of the committee's work, a commencement has been made in the matter of lectures to teachers. The movement among educational authorities in favour of a more enlightened use of museums calls for a knowledge on the part of teachers of the contents of these institutions. In Leicester the curator has arranged a series of lectures to local teachers, intended to show how the contents of the museum may be used to instruct and interest children in the subjects illustrated by the exhibits. The report also points out that a small vivarium has been commenced and has proved a great attraction to visitors. Various living examples of British reptiles, batrachians, and invertebrates are on show, as well as two or three exotic forms.

A recent number of *The Journal of Tropical Medicine and Hygiene* (vol. xv., No. 17) contains an account of the investigations on the etiology of pellagra carried on by Drs. Sambon and Chalmers, for which financial support was generously provided by Mr. Henry S. Wellcome. There are two opposed theories in the field with regard to the causation of this disease; according to the prevailing view, that of the "zëists," pellagra is the result of poisoning by unsound maize; Dr. Sambon, on the other hand, believes the disease to be due to infection by a parasitic organism, propagated by the agency of Simuliidæ, small biting flies which breed in running streams. As the result of epidemiological investigations carried on in many countries, Drs. Sambon and Chalmers have brought together a considerable body of facts and observations which tend to disprove, on one hand, any connection between pellagra and a maize diet, and to prove, on the other hand, that all areas in which the disease is endemic are situated in close proximity to streams in which Simuliidæ breed. It remains, however, for the parasitic theory of pellagra to receive definite proof by the discovery of the parasite (provisionally assumed to be "protozoal" in nature), and of its transmission and life-history.

The Museums Journal for September contains a notice, accompanied by a plan, of the proposed extensions of the Natural History and the Science Museums, based on "White Paper" Cd. 6221. It is pointed out that the housing of the Geological Survey and its collections in an extension of the eastern end of the Natural History Museum ought to prove advantageous on account of leading to greater facilities of cooperation between the palæontologists of the museum and the officers of the survey. On the other hand, the trustees of the British Museum are supported in their objection to the proposed removal and rebuilding of the spirit building at the Natural History Museum.

Under the heading of "The Insect's Homer," Mr. Maurice Maeterlinck directs attention in the September issue of *The Fortnightly Review* to a little-known work by J. H. Fabre, in ten volumes, entitled "Souvenirs entomologiques." Fabre, it appears, was a native of Provence, where his memory has recently been honoured by a special celebration. According to the author of the article, he was "one of the most profound and inventive scholars, and also one of the purest writers, and, I was going to add, one of the finest poets of the century that is just past." In these volumes, from which copious extracts are given, Fabre recorded the results of fifty years of observation, study, and experiment on a number of insects, including wasps and wild bees, certain gnats, flies, beetles, and caterpillars.

In the Bulletin of the American Museum of Natural History (vol. xxxi., p. 313) Mr. Abbott H. Thayer replies—and we venture to think very ably—to recent criticisms of his views with regard to cryptic and protective coloration in animals. After replying to objections that have been made against the protective nature of the "white-belly" type of coloration, the author directs attention to the extreme importance of the level from which the cryptically coloured animal is viewed. "An animal [such as a zebra] seen from a level above his own, has the dark earth for a background, while, at the very same moment, seen from two or three feet lower down [the lion's point of view] he has the bright sky instead, or is, at least, seen in the direction in which sky or glimpses of sky are to be expected. The moment this is understood, it becomes obvious that there is no such thing as a cryptic coloration *per se*, and that any amount of conspicuousness from all other view-points has nothing whatever to do with the question." The author illustrates this pictorially by means of a photograph of a "dummy" zebra and ass placed among thin scrub, and viewed from a lower level, when the former animal becomes practically invisible against the sky-line, while the latter stands out sharply silhouetted against the same.

The bright coloration of most Hemiptera is due to a fatty tissue known as pseudovitellus, and this tissue invades the developing egg at an early stage of maturation. Its significance has been variously interpreted, but only quite recently has its true function been discovered. Thanks to Sulc and Pierantoni, it is now known to be the habitat and to provide the food of multitudes of symbiotic organisms, probably yeasts. Every Aphis, every Psyllid, is a synthesis of two organisms, one the insect and the other the symbiont. Dr. Buchner, "Studien an intracellularen Symbionten" (part i., *Archiv f. Protistenkunde*, vol. xxvi., 1912), has taken up the detailed study of the range and nature of this form of symbiosis, and he gives a very interesting and well-illustrated account of his researches. Beginning with certain Coccidæ, in which the pseudovitellar cells may be present or absent (facultative mycetocytes), he proceeds to describe the definite organ (mycetom) which they form in Aphids and others. They may be infected by one kind of symbiont, by two kinds rigidly kept from commingling, or even (Psyllidæ) by three kinds. Similar symbiotic organisms are not limited to Hemiptera, and indications are given that they occur in cockroaches, beetles, Hymenoptera, and Lepidoptera. The organisms are carefully described, and the whole subject is one that deserves the fullest attention from botanists, and especially from mycologists. The relations between the insect and the symbionts are still in need of elucidation.

We have received from Messrs. Gallenkamp and Co., Ltd., Sun Street, Finsbury Square, E.C., a copy of their new catalogue of apparatus for botanical laboratories (List No. 61). This catalogue, in which every requisite for the study of plant physiology is listed, with numerous illustrations of special apparatus for physiological experiments as well as of general laboratory materials, is indispensable to teachers of botany. The chief feature of the catalogue is the listing of the apparatus described in standard text-books on plant physiology; the portion dealing with botanical material and slides contains a rather large number of misprints in the names of plants.

Mr. O. F. Cook has published an interesting note in the Journal of the Washington Academy of Sciences (vol ii., No. 9) on the morphology of the leaf in various members of the Prunus section of Rosaceæ, sometimes regarded as a separate family (Amygdalaceæ). The leaves of plum, peach, apricot, &c., have a joint at the base, just above the insertion of the stipules, as in many leguminous plants; the part below this joint does not fall off with the leaf-stalk, but remains alive and forms a supplementary bud-scale. This is regarded as a vegetative character which supports the view that the Amygdalaceæ are deserving of family rank, and also as strengthening the connection between the rosaceous and leguminous series. The fact that small leafy outgrowths sometimes replace the nectaries on the upper part of the leaf-stalk in various Amygdalaceæ suggests the view that the immediate ancestors of this family had compound leaves, these nectaries corresponding to the marginal glands of the leaf-blade and representing rudiments of divisions of compound leaves.

Mr. F. W. Clarke returns to the consideration of the average composition of various rocks in a paper on some geochemical statistics (Proc. Amer. Philosophical Soc., vol li., 1912, p. 214). His results give us an average igneous rock with a silica percentage of about 60, and the "surprising conclusion" (p. 227) that the volume of limestones in the crust is less than that of the salts dissolved in the ocean. The relation of these salts to the earth's age is again referred to.

Dr. Vaughan Cornish considers the origin of the Jamaica earthquake of January 14, 1907, in a short paper in *The Geographical Journal* for September. In his account of the earthquake published in the same journal for March, 1908, he shows that the destructive intensity of the earthquake was almost limited to a narrow zone crossing the island from near Kingston to Buff Bay on the north coast. The earthquake evidently originated in two foci, one near the mouth of the river Hope, a few miles east of Kingston, the other about ten miles to the north in the neighbourhood of the head-waters of the river at Hardware Gap. The earthquake could be assigned to no known fault, but, as shown by the small extent of the area of destruction, the depth of the foci must have been inconsiderable. Dr. Cornish therefore attributes the earthquake to the redistribution of stresses in the surface-crust through the action of river-denudation, the added load near the mouth of the Hope river causing a subsidence along a shallow-seated fracture, while the diminution of pressure among the mountains at Hardware Gap would, he thinks, result in elevation along another fracture.

The report of the Sonnblick Society directs attention to the fact that in September, 1911, the Sonnblick Meteorological Observatory, at an altitude of 3105 metres, completed the twenty-fifth year of its useful work. It is the highest in Europe which has a resident staff all the year round, and was established by the Austrian Meteorological Society at the instigation of Hofrath Dr. J. Hann. At the end of 1892 it was in danger of being relinquished owing to the want of funds, when the Sonnblick Society was formed and came to its rescue by obtaining subscriptions, which are still continued. Later on the permanency of the establishment was assured by a Government grant in aid. The following data are extracted from the published results for 1911:—

	January	July	Year
Mean temperature (C.)	−13·4°	2·2°	−5·9°
Absolute maximum	−4·4	10·1	10·1
,, minimum	−28·5	−5·6	−28·5

The melted snow and rain for the year amounted to 1398 mm., on 229 days. Rain was only measured on a few days from June to September. Fog occurred on 230 days.

In the Journal of the Meteorological Society of Japan (vol. xxxi., No. 7) Mr. G. Ishida describes some experiments carried out at Hamada with the view of improving the efficiency of storm warning signals at night. In the tests two kinds of oil lamps were used, provided respectively with circular and flat wicks.

Observers were stationed at various distances up to 5·4 kilometres from the signals, and naked-eye records were taken. There were three sets of experiments, to determine (1) the relative advantages of circular and flat-wick lamps; (2) the range of red and green lights; and (3) the distance at which two separate lights can be distinguished. The results showed (1) that the light from the flat wicks was considerably brighter at a distance than that from the round wicks, particularly when the line of vision formed a right angle with the sides of the wick, and (2) that the range of the red lights (flat wicks) was approximately double that of the green, the latter being scarcely visible at 3 kilometres, while the former were still bright at 5 kilometres. In the third set of experiments observations were taken at distances of 2 and 3 kilometres of pairs of lights separated by intervals of 2, 3, 4, and 5 metres. At 3 kilometres none of the pairs were distinguishable as separate lights when the space between them was less than 4 metres. With a separation of 2 metres red or green pairs were merged into one bright light. When red and green lights were shown simultaneously, the green light was eclipsed altogether by the red at 2 kilometres if the distance separating them was not more than 2 metres.

PART 15 of the *Verhandlungen* of the German Physical Society contains a description of a mechanical pump for high vacua recently devised by Dr. W. Gaede, which makes use of a principle not previously utilised in the construction of such apparatus. If a shaft revolving in a well-fitting bearing has a circular slot cut in it, the air in the slot will to a large extent be carried round with the shaft. If at one part the bearing projects into the slot so as to fill it completely, the gas in the slot will be carried round with the shaft from one side of the projection to the other, and the pressure will in consequence be less on one side than on the other. If two openings are made through the bearing, one on each side of the projection, air will be drawn in through one and delivered through the other. By making a number of slots in the shaft and connecting the openings into them in series, the action will be intensified. A pump constructed on these lines exhausts five or ten times as fast as one of Dr. Gaede's well-known mercury pumps taking the same power, and deals with the water vapour as well as the gas, so that no drying materials are necessary. As it works better at low than at high pressures it is run in conjunction with another pump, which reduces the pressure to a few centimetres of mercury.

IN a publication of the *R. Accad. delle Sci. dell' Inst. di Bologna*, which has recently come to hand, Prof. A. Righi describes some interesting experiments on the emission of ions in directions perpendicular to that in which the main discharge passes. Two wire electrodes are sealed into a cylindrical vacuum tube, perpendicular to the axis, with only their points exposed. When an impulsive discharge is passed between them it is found that ions are shot along the axis of the tube. The distance they penetrate and their relative numbers under different conditions are studied by collecting them in a suitably placed Faraday cylinder. By an ingenious arrangement of vanes, which rotate when the ions strike them, it is possible to follow the paths of the particles. This transverse emission of ions is most vigorous near the ends of the main discharge. When the tube is placed in a magnetic field parallel with its axis the neutral doublets, already investigated by Prof. Righi in earlier papers, are formed, and, as would be expected, the Faraday cylinder collects less charge. On the other hand, owing to the large mass of the doublets, the mechanical effects are increased.

AN article in *Engineering* for October 11 recalls the discussion of a few years ago on the distribution of shearing stresses on the horizontal layers of a dam. Messrs. Wilson and Gore showed experimentally in 1908 that the stresses did not follow a parabolic distribution, but were much more uniform. Prof. E. G. Coker has lately described experiments at the Royal Society on thin celluloid sheets under shearing stress, the conditions resembling that of the web plate of a plate girder. It has been contended that the shearing stresses in the girder web follow the parabolic law, but these experiments indicate that this law is only approached when the plate is shallow. Otherwise the shear curve had no maximum at the centre of the specimen, but showed two equal maxima, which are at points situated at a distance from the ends equal to rather less than the width of plate under test. Reducing the depth of the plate causes these two maxima to approach each other, and they finally coalesce when the depth of the specimen is about equal to its width.

A SECOND edition of Mr. T. H. Byrom's "Physics and Chemistry of Mining: an Elementary Class-book for the Use of Mining Students," has been published by Messrs. Crosby Lockwood and Son. In this edition the chapter on magnetism and electricity has been omitted, and additional matter has been introduced in both the physical and chemical sections. The price of the volume is 3*s*. 6*d*. net.

MESSRS. H. F. ANGUS AND CO., of Wigmore Street, London, have issued a new catalogue of second-hand scientific apparatus and accessories which are available for sale, exchange, or hire. We notice that all the instruments listed, unless otherwise stated, have been tested, adjusted where necessary, and are capable of work of equal precision as when new. Interesting particulars are given in the list of microscopes and accessories, as well as of various other optical instruments.

OUR ASTRONOMICAL COLUMN.

GALE'S COMET, 1912*a*.—London urban skies have remained comet-proof for some time now, but Mr. Franks, writing to *The Times* (October 15), reports that he saw Gale's comet very well, with a 6-inch refractor, during the week ending October 11, at East Grinstead. He states that it appeared to be brightening, for it was about fifth magnitude when he first saw it, and was nearer fourth on October 11. On this date it was a fine object, plainly seen in the finder, and, by sighting along the telescope, it could be seen by the naked eye as a misty spot about half a degree below α Serpentis. When seen on a dark sky it presented an extensive coma with a large bright nucleus and a tail at least half a degree in length. Mr. Franks also reports that it was nearly a degree north of its predicted position on October 11, and that the difference is increasing, but it seems probable that he was using the earlier ephemeris published by Dr. Ebell, and not the later one from which we gave an extract last week. The following is a continuation of the corrected ephemeris :—

1912	α (true)	δ (true)	1912	α (true)	δ (true)
	h. m.	° ′		h. m.	° ′
Oct. 18	...15 49·9	...+13 20·0	Oct. 22	...15 54·1	...+16 52·0
19	...15 51·0	...+14 14·6	23	...15 55·1	...+17 42·5
20	...15 52·1	...+15 8·2	24	...15 56·1	...+18 32·0
21	...15 53·1	...−16 0·6	25	...15 57·0	...+19 20·5

According to this ephemeris, the magnitude should now be 6·6, and decreasing slowly, but, as Mr. Franks remarks, the comet is exceeding expectations, and, with its indications of abnormal brightening, may well repay careful observation, especially in the form of a close series of photographs, by those who are favourably situated; on October 21 the comet will be about one-third of a degree east of γ Serpentis.

THE RECENT TOTAL ECLIPSE OF THE SUN.—It is with much regret that we learn from Greenwich that all attempts to make observations of the recent total eclipse of the sun were frustrated by the heavy rain which prevailed in the eclipse region of Brazil on eclipse day, October 10. The Greenwich observers, Messrs. Eddington and Davidson, were located at Alfenas, an elevated village some 185 miles north of Santos, where there were also eclipse parties from France, Germany, Brazil, and other countries. The Brazilian officials rendered all the assistance they could, and the Government voted a sum of 5000*l.* for the reception of the visiting astronomers at Rio. According to a characteristically interesting letter from Mr. J. J. Atkinson, which appeared in *The Morning Post* on October 8, the Greenwich equipment weighed about three tons, and had to be transported from Rio to the terminus of the State railway, a distance of about 150 miles towards the mountains; owing to the sharp incline the latter part of the track has to be worked on the cog system. Mr. Atkinson, who accompanied the Greenwich observers as a volunteer, also recites some interesting reminiscences of his previous eclipse experiences.

THE CONSTANT OF ABERRATION.—In No. 15, vol. xxvii., of *The Astronomical Journal*, Prof. C. L. Doolittle gives the result of twenty-two determinations of the aberration constant derived from thirty-two years' latitude work at the Sayre and Flower Observatories. The observations were made at two different places, with what are practically four different instruments, only the observer remaining the same, and the mean probable error is less than 0·01″. Taking the weighted mean of all the observations, Prof. Doolittle finds for the constant the value 20·525″ ± 0·0043″, and the corresponding value for the solar parallax is 8·780″.

THE AUTUMN MEETING OF THE INSTITUTE OF METALS.

THE papers presented at the autumn meeting of the Institute of Metals, which took place at the Institution of Electrical Engineers on September 25 and 26, may be divided into two groups according as their interest lies principally on the practical or on the scientific side.

Among the "practical" group two papers dealing with the joining of non-ferrous metals and alloys may be mentioned. In these Prof. Carnevali, of Turin, and A. E. Tucker, of Birmingham, discuss the question of autogenous welding, although the latter paper also deals in an interesting if somewhat scrappy manner with many other processes, such as soldering and brazing, &c. In view of the great extension of autogenous welding by means of oxygen and acetylene, the question how far the results of this process can be trusted is an important one. Tucker appears to regard a weld as satisfactory if it is found on testing it to destruction that the fracture occurs away from the weld itself. As a matter of fact, however, the weakest portion of a welded joint, as Carnevali points out, is not the weld itself, but the region of injured metal on either side of it. According to this author the strength of welds in copper and its principal alloys cannot be depended upon, and this conclusion agrees with the views on autogenous welds in iron and steel recently expressed by Fremont and others. In regard to pure aluminium, however, Carnevali finds the method to give satisfactory results, but the efficiency of a weld is much reduced as soon as it is applied to one of the stronger light alloys of aluminium. Broadly speaking, these papers lead one to view the rapid development of autogenous welding practice with some suspicion.

Still on the "practical" side were a number of papers dealing with impurities in copper and copper alloys. An interesting and suggestive paper by E. F. Law dealt with oxygen and oxides as deleterious impurities in alloys. This author took the view that progress in non-ferrous alloys was largely a question of the better elimination of oxides, and this view was strongly supported in the discussion by Rosenhain. The paper by Prof. Turner, however, emphasised the existing difficulties in the way of analytical determination of oxygen in brass, and an appeal was made to chemists to devise a satisfactory method for this purpose. F. Johnson dealt with the effect of impurities, chiefly antimony, on the properties of tough-pitch copper, and here again discussion centred round the part played by oxygen. The lenient view as to the deleterious effects of antimony put forward by the author was, however, strongly opposed by all those who have to deal with copper on the large scale. Other papers of a "practical" character dealt with high-temperature tensile tests on copper and its alloys, and with the annealing of coinage alloys, and both these papers were vigorously criticised in the discussion on the ground of the experimental methods employed by the authors.

The "scientific" papers were not so numerous, but of special interest. Prof. H. C. H. Carpenter contributed two papers dealing in further minute detail with the inversion which he has discovered in a certain range of copper-zinc alloys (brass) at a temperature of 470° C. In one of these papers the author deals with the effect of impurities on this inversion and finds that any addition of a third metal to these alloys tends to facilitate rather than to inhibit the transformation in question; since the change renders the metal weak and more brittle, it is evident that the use of the purest copper and zinc is desirable in the manufacture of those varieties of brass containing the constituent.

In a very short note Dr. G. T. Beilby, F.R.S., discusses the phenomena of the solidification of metals from the liquid state in reference to the "foam cell" theory of Quincke. In his May lecture to the institute, Dr. Bielby had suggested the importance of a full experimental investigation of the views put forward by Quincke, and the present note is intended to state more precisely the problem which Dr. Beilby desires to see investigated. The fundamental question, which goes beyond Quincke's hypothesis, is this, whether the liquid metal undergoes any changes or separations before actual solidification commences, and, if so, whether there is really any formation of foam cells or analogous structures governing the crystallisation of the metal. In his note Dr. Beilby quotes some lines of evidence from the manner in which a thin film of fused salt or other substance solidifies on a glass slip which appears to be strikingly contradictory to Quincke's views, and indeed the impression derived from reading Dr. Beilby's note is rather that he finds the "foam cell" theory less attractive after thus considering it more closely. A practical result is, however, likely to follow from Dr. Beilby's interest in the matter, in the shape of an exhaustive report on our present knowledge of the passage from the liquid to the solid state in metals, prepared under the auspices of a committee of the Institute of Metals, and this will certainly be very welcome.

Of purely theoretical interest is the paper presented by Dr. Rosenhain and Mr. Ewen, of the National Physical Laboratory, on the intercrystalline cohesion of metals. In this paper the authors advance the hypothesis that the crystals of a pure metal are held together by the action of a thin layer of metal in the amorphous condition forming a species of cement between the crystals. The conception of the existence of such a cement has already been put forward by Bengough and by Osmond, but the authors claim to have used it as a working hypothesis in their own laboratory before others had published their views. The paper begins with a detailed discussion of the general facts which lead in the first place to the idea that there should be some special condition at the boundary surfaces of crystals in solid metals; perhaps the most striking of these facts is the strength of these bounding surfaces, since it has been conclusively shown that pure metals normally undergo fracture through the crystals and not along the boundaries between them; the cohesion across these bounding surfaces is thus stronger than that across the cleavage planes of the crystals themselves.

The authors next suggest in general terms that when two growing crystals approach one another, a region is formed at their boundary in which the molecules are no longer able to assume the crystalline arrangement, and they further point out that if the unit or element of which the crystal is built up is large compared with the "liquid" molecule, then at the junction of two crystals gaps must remain which are too small to contain another complete crystal unit and that consequently such gaps would ultimately be filled by undercooled liquid metal which had been unable to crystallise. This undercooled liquid would then be identical with the "amorphous phase" of Beilby, and would possess similar properties. The paper points out that Beilby has shown that the amorphous phase is more soluble in acids and possesses greater chemical activity than the crystalline phase, and it would accordingly possess a higher vapour pressure under corresponding conditions of temperature. It follows that if two pieces of the same metal, one containing a small and the other a relatively large proportion of amorphous matter, were heated to the same high temperature in a high vacuum, the one containing the larger proportion of amorphous matter would lose weight more rapidly than the other.

This conclusion the authors have submitted to the test of experiment in the following manner. If an amorphous intercrystalline cement exists, then a specimen of metal consisting of a few large crystals would contain less of this amorphous material than a piece of the same metal which consists of a very large number of minute crystals, since the material of the cement is chemically identical with the bulk of the metal. Specimens possessing large and small crystals respectively were prepared by the authors in various ways, and these specimens were heated in high vacua (0·005 mm. and under) at temperatures sufficient to produce considerable volatilisation losses,

FIG. 1.—×100.

but still well below the melting points of the metals in question.

In the case of silver, zinc, and copper the authors found their expectations verified; the specimens possessing the minute crystal structure in every case losing weight at a greater rate than the coarsely crystalline specimens. The differences found were, in fact, considerably greater than the amount of amorphous cement which could reasonably be supposed to exist in the specimens, but although this point was

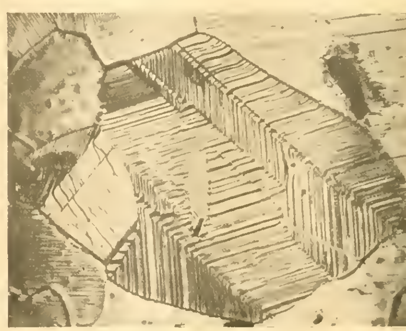


FIG. 2.—×200.

somewhat laboured in the discussion, the authors offer a fairly satisfactory explanation by showing that the formation of fissures due to the evaporation of the "cement" allows all the crystals in the fine-grained metal to undergo volatilisation from all their surfaces, so that after a time the effective evaporating surface of the fine-grained specimen is much larger than that of the coarse-grained.

This explanation is supported by microscopic evidence, since the widening by evaporation—of the intercrystalline boundaries is clearly visible on the specimens. An example of the channels formed in this way is shown in Fig. 1, reproduced from the paper. An interesting confirmation of the authors' views is further found in the fact that while the boundaries between adjacent crystals always exhibit this deep channel, the boundaries of twin-crystals do not show such a groove; since the crystal units on either side of a "twin" boundary fit into one another in a regular manner there is no room for amorphous matter in these boundaries, hence the absence of the groove. With the metals antimony, cadmium, and aluminium the authors obtained irregular losses of weight which neither confirmed nor refuted their views; they put these views forward merely as a suggestive working hypothesis, and do not claim to have furnished a valid proof of its truth.

Incidentally, the method of heating metals in high vacua furnishes an interesting means of developing their micro-structure, and this method has been used by the authors to study the conditions under which twinned crystals are developed in silver. One of their photomicrographs showing the structure of a twinned crystal of silver is reproduced in Fig. 2.

THE SURFACE-TENSION OF LIVING CELLS.[1]

PROF. CZAPEK'S pamphlet contains most important experimental work upon one of the fundamental physical attributes of the living protoplasmic cell, namely, the surface-tension of its external limiting layer. He makes it clear that the tension conditions obtaining in this layer, which intermediates between each metabolic unit and its environment, are of great significance for secretion and for absorption, and he has established that the surface-tension of the cells of the higher plants is maintained fairly constant at the value of about 0·685, the surface-tension of water in contact with air being taken as unity.

This very important conclusion is the outcome of a line of research which began at an apparently remote point, the successive stages of which may be briefly set out. The work started with the investigation of the curious precipitates that could be produced in the living cells of many plants by the action of dilute ammonia or 0·2 per cent. caffein, such as had been described as "aggregation" by Charles Darwin, in the tentacles of Drosera. Czapek first established that this "myelin-like" precipitate is a compound of caffein with the soluble tannin of the living cell, and is produced in all cells that contain tannin, the mesophyll of Echeveria and Sedum being the most suitable material. He then found that if such living cells are immersed in solutions of organic substances for some hours, the power of giving a precipitate with caffein may be entirely lost. This loss was traced to exosmosis of the tannin from the living cell, and it was further found that for each organic substance there was a particular limiting concentration below which no effect was produced and above which the exosmosis became very rapid. On comparing these limiting concentrations for the series of monovalent alcohols it was found that at each step in the homologous series the molecular concentration required diminished to one-third. Such a relation was, however, exactly what Traube had established for the surface-tension effect of the members of this series.

[1] "Ueber eine Methode zur direkten Bestimmung der Oberflächenspannung der Plasmahaut von Pflanzenzellen." By F. Czapek. Pp. iv+86. (Jena: Gustav Fischer, 1911). Price 2.60 marks.

Following up this clue, Czapek measured the surface-tension of a large number of solutions of organic substances, and compared their action in causing exosmosis from the cell with their activity in lowering the surface-tension of water. He thus was able to establish securely the unexpected generalisation that *on dissolving in water sufficient of any organic substance whatever to lower the surface-tension to about* 0·685, *a solution is obtained which just causes the exosmosis of the contents of living cells.* The critical concentration may require twelve to twenty-four hours to produce its effect, but stronger solutions with a lower surface-tension work very quickly and thoroughly, so that after a short time treatment of the cells with caffein gives no intra-vital precipitate at all.

The power of the protoplast to retain its dissolved contents is thus shown to be a matter of physical organisation, depending upon the surface-tension of the cell being below that of the medium in contact with its outer surface.

From true solutions Czapek passed to try the effect of emulsion-colloids of a lipoid nature (proteids and carbohydrates do not lower surface-tension enough to give the critical value of 0·685). The lipoid emulsions are, however, extremely active, and give exactly the same effects as true solutions.

The last step in the progress was an attempt at identification of the substance actually present in the plasmatic membrane which causes it to have normally so low a surface-tension as 0·685. Czapek finds that saturated emulsions of neutral fats lower the surface-tension just to this value and no further, so that it seems very probable that these are the effective substances in the living cell.

We have thus striking support for the view, widely adopted from the work of Overton and Meyer, that the plasmatic membrane is of a lipoid nature. Overton's later view was that lecithin and cholesterin rather than neutral fats were the particular lipoids present, but these give a lower surface-tension down to about 0·5. The present line of work indicates that these may be the effective substances in some cells, not those of the higher plants, for yeast and red-blood corpuscles require a medium of about this lower surface-tension to bring on exosmosis of invertase and hæmoglobin respectively.

Many supporters of the lipoid theory of the constitution of the plasmatic membrane have interpreted it to mean that there exists at the surface of the cell a continuous film of a lipoid nature, and this has raised difficulties in understanding the intake of typical nutrient substances which are freely soluble in water, but not in fat. Czapek points out that an emulsion containing only a small percentage of fat is all that is needed to endow the cell with the observed specific properties.

Willard Gibbs showed from thermodynamical considerations that substances in a solution which strongly reduce surface-tension must accumulate in the surface-layer until their return by local excess of osmotic pressure produces a state of equilibrium between the surface and the mass. With emulsified fat particles, however, the osmotic pressure is very slight, and very great accumulation in the surface-layer must result.

This piece of work may serve as a model of scientific method on account of the way in which the mysterious phenomenon of "aggregation," described by Charles Darwin, has been followed on and on until it has led to the evaluation of so fundamental a vital constant as the surface-tension of the living cell.

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THE BRITISH ASSOCIATION AT DUNDEE.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY PROF. JOHN ADAMS, M.A., B.Sc., LL.D., PRESIDENT OF THE SECTION.

An Objective Standard in Education.

Of those who deny to education a place among the sciences the name is legion, for they are many. The mere classification as a science is not perhaps of much consequence, but it is useful for the student of education to examine the popular view, and see how far it is justified. The following statement, the words of a former occupant of this chair, will be generally accepted as representing the prevailing opinion:—

"If we take science to mean, as commonly understood, organised knowledge, and if we are to test the claim of any body of facts and principles to be regarded as science by the ability to predict, which the knowledge of these facts and principles confers, can we say that there exists an organised and orderly arrangement of educational truth, or that we can logically, by any causative sequence, connect training and character either in the individual or in the nation? . . . It is very doubtful whether we can say that educational science is yet sufficiently advanced to satisfy these tests"

First, with regard to organised knowledge, there is certainly a great mass of matter available in the subject of education. It is true that there is nothing easier than to show that this matter is not at present well organised. It is only too easy to find examples of contradictions among those who make a study of education and venture to write or speak on the subject. We are told that there is scarcely any important statement made by a writer on education that cannot be met by a direct contradiction in the works of some other educational writer. It has to be admitted that writers on education in the past have been strangely opinionative and dogmatic in view of the very complex and delicate problems they have had to handle. Too frequently they assumed a simplicity in their subject-matter that was certainly not there. Even the massive common sense of Dr. Johnson was not able to keep him from regarding education as a study that had reached its limits long before his time. But between those who regard education as too simple to need any further examination, and those who treat it as so complex as to defy human analysis, there are those who take the view that education is a science like any other, though they admit that there may be room for wide difference of opinion regarding the stage of development it has reached.

At the present moment it is becoming increasingly evident that educational theory is consolidating: it can now be claimed that there exists a great body of educational doctrine that is of general acceptation. It need scarcely be said that there are many and deep differences among the various schools of educational writers. But if we compare any two schools we shall find that the points of agreement far outnumber the points of difference. This was true even in the older times of naïve theory, but is making itself very evident in these latter days. Anyone who has occasion to read all the books on the theory of education as they appear is impressed in spite of himself by the large body of doctrine that is common to them all. It is not that the books lack originality: each writer has his new point of view or his new interpretation of certain phenomena; yet each either baldly states or tacitly takes for granted a great body of truth that is held to be generally accepted. This body of recognised truth is gradually increasing as the result of collective thinking and the corrections involved in active criticism. Already critics are beginning to find fault with any writer who produces a book—not avowedly a text-book—that professes to deal with the whole range of education. He is reminded that what is now wanted is a special development along certain definite lines. The general principles of education are held to be established and accepted.

In confirmation of what has been said, it may be added that within the past year or two have appeared no fewer than five separate treatises each bearing the same title: "The Principles of Education." These books are mainly for the use of students, and contain what are regarded as the accepted results of educational investigation up to the present date. Their authors obviously recognise the existence of a certain body of truths on which all are agreed. In some of the professions it is customary to speak familiarly of "the books," meaning the standard works to which appeal is constantly being made. If among teachers we have not yet reached this stage, we are obviously far on the way towards it. The books are there, but the profession needs some time yet before, in its own deliberate way, it recognises their importance. By and by it will realise the fact that it has at its disposal material that will enable it to prophesy, and thus fulfil, the second condition imposed upon all who lay claim to scientific knowledge. It is true that in the past there was little diffidence about prophesying: it was the fulfilment that gave trouble. Wolfgang Ratke supplies, if not the first, at any rate the most dramatic application of a control test in the working of educational prophecy. He went to prison because the people of his time did not make allowance for the insufficiency of the body of knowledge on which he based his predictions. There was indeed nothing scientific about the procedure of Ratke. He was at the empirical stage, and could not rise above it. His modern fellows have not quite got beyond the empirical, but they are on their way.

No claim is here made that Education has yet justified her demand to be recognised as a fully developed science; but it may be fairly maintained that she has at least entered upon the stage of scientific method: she is seeking to free herself from mere empiricism. In such a struggle there are at least two possible lines of action.

The first requires some ingenuity, but is natural and pleasant. It consists in superimposing principles upon the facts of the case. The educational theorist invents or assumes certain broad general principles, then proceeds to fit in all the observed facts, and often shows great skill in the process. This method is of very general application. Sometimes it is worked consciously and deliberately, as in the case of Socrates' doctrine of Reminiscence. Here we have the whole scheme of teaching simplified by this superimposed generalisation. Quite frequently, however, the broad underlying principles are not brought to clear consciousness, and are, in fact, sometimes contradictory to each other. Examples may be found in Rousseau. For our present purpose this tendency towards what may be called rational pedagogy is best illustrated in the system of education elaborated by Herbart. Though the metaphysical basis on which he builds is generally regarded as false, it was deliberately adopted by him, and if it is once granted to him, all the rest of his system must be admitted to be built up on strictly scientific principles. It is true that while logically Herbart's pedagogy was built upon his psychology, in point of fact his pedagogical thinking preceded and dominated his psychological theory. While Pestalozzi sought to psychologise education, Herbart may be said rather to have educationalised psychology. In any case, he supplies us with a system that challenges recognition as scientific, whether the claim be admitted or not.

The other method by which a study may seek to escape from mere empiricism is by dealing with observed results so as to reach the underlying principles. In this method, instead of setting up principles and making the facts square with them, we examine the phenomena and seek to discover the underlying principles. Obviously this at once introduces the experimental method, since no satisfactory progress can be made by mere passive observation. This is the stage we have now reached in educational theory. We are passing from an appeal to experience to an appeal to experiment. Naturally, educational method has always had to stand or fall by its results, but in estimating results there has too frequently been a confusion between cause and effect. So soon as a conscientious analysis of educational problems is attempted, there comes the need of experiment. Certain questions have arisen demanding a definite answer, and the answers supplied must stand the test of practical application. Education is, in fact, called upon to prophesy, and to stand or fall by the results. Now the method of experiment is really a system of tentative prophecy, under rigidly determined conditions. We acquire skill in prophesying by a process of trial and error. We become prophets by prophesying. From all the knowledge at our disposal we calculate that a certain process will give a certain result. We apply the process, and then if the result is not what we expected, we examine all the conditions, seek out the cause of our error, and proceed to another tentative prophecy. By and by we acquire the power of prophesying with confidence within certain recognised limits, and within those limits we may claim to proceed scientifically.

But in the evaluating of results that is necessary in this process of training in prophecy there is need for some recognised standard. Unless this condition be fulfilled there can be no general agreement among investigators. Accordingly, the first step in raising a study to the scientific level is the establishment of such a standard. In the study of education in the past—and it must be admitted that the same is true to a large extent at the present—the standard adopted was in most cases a subjective one. There is a tendency to have everything determined by individual opinion. Certain educational processes are gone through; certain results follow in the lives of the educands. The casual relations involved are arranged by the individual observer to suit his own views. According to some, the battle of Waterloo was won on the playing-fields of Eton; according to others, the battle of Colenso was lost there. We have need of some standard that is independent of private opinion.

Obviously the whole question of the relativity of knowledge is here involved. The educator is too apt to apply to his own case the Protagorean view, and maintain that "man is the measure of all things; of things that are, that they are, and of things that are not, that they are not." Into this antique problem we need not here enter. There is a sense in which the epigram of Protagoras may be justified. Without doubt, for his own practical purposes, the individual is the measure of his universe of experience. But so far as his universe has to do with the universes of others, the individual needs some common standard, something outside of himself, something that others besides himself recognise—in short, an objective standard.

The matter may be illustrated by what took place in the development of certain of the sciences. The secondary qualities involved in the Lockean epistemology—such things as colours, tastes, smells, sounds—lend themselves to a subjective standard; but so long as we confine ourselves to a standard of this kind we cannot be said to treat such matters scientifically. The individual is the sole judge of how a particular sound or colour strikes him, and against his decision there is no appeal. But it seems as if we could not have a science of sounds or of colours based on this individual judgment. Each observer would rely upon his own sensations, and would interpret them in his own way. Fortunately, in the study of physics it was discovered that certain of the conditions of sensation are constant. When we get a knowledge of wave-lengths, and the laws of refraction and reflection, we have passed from the merely subjective sphere, we have an outside standard, we can compare, abstract, and analyse independently of the individual. "C natural" has a definite meaning to science, even if there were not a single ear that could hear the sound. It is true that, in the ultimate resort, we cannot eliminate the individual observer. He is too important in ordinary life, and a great deal of the work of science is done, after all, at his address. How *red* strikes an observer is as important to a man of science as is the exact wave-length that is necessary to produce *red*. The relation between a certain wave-length and a certain sensation is complicated by the individual peculiarities of the sense organs of the living being concerned. In certain respects the science of optics is self-contained, and has a definite objective standard. In certain other respects it depends for its data on individual experiences, and has to content itself with a subjective standard. No doubt it can call in the aid of physiology, a science that has an objective standard of its own, and in this way eliminate a certain amount of subjectivity. But in the last resort there is a corner of the field in which no objective standard can be obtained.

It is true that in pure mathematics we appear to get into a region where the subjective may be practically excluded altogether, but even here the science of space and time is limited by the fact that it can deal with its data only from the point of view of human limitations. And there are certain borderline studies that are mathematical in their essence, yet have a direct reference to our bodily organs. Linear perspective, for example, is usually regarded as a science, indeed, as an exact science. Yet when we look into the matter we find that linear perspective is nothing more than a conventionalised method of treating, in an exact way, the results of individual experience. The whole science is really an objective standard by which the ordinary processes of vision may be compared, analysed, and classified. Perspective tells us what we ought to see. It is not independent of our sense functions, it is only a mode in which the variable subjective is reduced to uniformity by the application of the objective standard. Indeed, in the teaching of art there sometimes arises a curious conflict between the subjective element and the objective. Students who have studied perspective before they are called upon to draw real objects set before them are very apt to draw according to the rules they have learned, instead of observing what is actually before them and reproducing that as it appears to their senses. In other words, they set up the objective standard as paramount. So markedly is this the case that sometimes the study of perspective is forbidden until familiarity with model drawing has been attained. When a teacher urges a pupil to draw what he sees, and not merely what he knows from the rules of perspective he ought to see, we have an appeal to the subjective standard. The teacher is turning from the science of perspective to the art of drawing.

This illustration is of particular advantage to us in our present work, because it not only exhibits the subjective standard working alongside of the objective, but it introduces the idea of an *exact* science in relation to our human organs. Astronomy is an exact science, and yet the problem of the "personal equation" shows that even here the subjective must be taken into account. The "personal equation" is, in fact, nothing but the elimination by quantitative methods of the disturbing subjective elements. It is by similar methods that we must seek to establish an objective standard in education. The difficulty in this subject is very great. Astronomy and physics touch the subjective only at what may be called the point of application the point at which they are brought into contact with human life. Their subject-matter is external, and lends itself to objective treatment. In education the subject-matter is human nature, which is so complex and involves such volatile elements that it is almost impossible to reduce its working to fixed laws. The same difficulty obviously applies in psychology. Itself a comparatively new subject, psychology has great difficulty in getting recognition as a science. For this there are two main reasons. To begin with, psychology began life as a branch of philosophy, and scientific men regard with suspicion anything that comes from that quarter. Besides, there was the less reason to make room for the new subject, since it had already a settled place in the hierarchy of studies. The second reason is that which interests us here—the difficulty of establishing an objective standard. The descriptive generalities of Dugald Stewart and Thomas Brown had to give way to something based upon laws that are generally accepted. The line of least resistance in seeking for an objective standard in psychology is to fall back upon a physiological basis. It is generally admitted that nerve action can be referred to an objective standard, and by correlating psychic and bodily phenomena psychologists are able to get a series of recognised principles on the physical side that may be easily interpreted in terms of spirit. Psychophysics has at least a plausible claim to rank among the sciences, and the unbridged gulf between mind and matter is conveniently ignored. As a matter of fact, such a generalisation as the Fechner-Weber law ranks parallel with the laws of linear perspective—that is, it is a law that states in an unjustifiably exact way what ordinarily takes place in the individual experience. While rejecting the materialistic alliance, Herbart, as a psychologist, deliberately set up a mechanical system of ideas as forces, and in this way established at once an objective standard by means of which all mental process may be understood and manipulated. So scientific is his system that he claims that the interaction of the ideas may be calculated in certain cases by a simple application of the rule of three. With Herbart, psychology has certainly been raised to the rank of a science; but unfortunately it has to be admitted that his objective standard has been illegitimately assumed.

Just as psychology utilises physiology in its effort to gain a standing as a science, so education is inclined to use psychology. Frequently we hear psychology described as a science, while education is relegated to a place among the arts. It is natural, therefore, for the educator who wishes to claim rank in science to appropriate the scientific status of his auxiliary science. As a matter of fact, education has captured psychology. This is only one of many cases in which a profession has taken possession of an abstract study, and in this way enabled the abstract study to make real progress. Theology as a study has gained greatly by the fact that it is a compulsory subject for those who are preparing for a great profession. Astronomy owes a great deal to the support it has received from its practical value to navigators. Physiology would not be what it is to-day had it not become an essential subject in the preparation for the practice of medicine. Physiologists sometimes complain that their subject is hampered by its professors having to waste time in teaching mere medical students; it is well to remember, however, that but for the demands of the medical profession physiology would have been left to the few private investigators who might be able at their own cost to carry on under adverse conditions the work that is now being done in thousands of well-equipped laboratories. In the same way it is greatly to the advantage of psychology that it has become an essential part of the professional training of teachers. The subject is now receiving an amount of attention that it would never have had but for the support of its connection with the profession of teaching. But after all a teacher is not a mere psychologist: education is more than applied psychology. If education is to rank as a science, it cannot be in virtue of its use of another study that itself has an insecure foothold among the sciences. It must establish for itself an objective standard.

Mere quantitative manipulation of the elements of a study, if only carried out on a sufficiently large scale, has a tendency to evolve an objective standard, apart from any deliberate search for such a standard. We may gather something from an examination of a standard of this kind that, unexpected and unsought, evolved itself in the ordinary course of educational administration. What Binet and his colleagues and followers have been trying to do of set purpose was, to some extent at least, accomplished automatically by the working of the system of individual examinations under the English and Scotch codes of elementary education. Binet has drawn up certain tables with the express purpose of testing the intelligence of children at various ages. But we are only at the threshold of investigation work of this kind, and the tests cannot be regarded as satisfactory, either in themselves or in their application. But they have been drawn up with the deliberate purpose of supplying a more or less objective standard of intelligence. Now in the British elementary school codes we have the examination requirements from the pupils of different ages set out in a series of tables each corresponding to one of the seven grades known technically as "standards." The purpose of these tables of requirements was not primarily to determine the intelligence of the pupils, but rather to indicate certain minimum amounts of information that had to be communicated in consideration of a certain money payment. Yet these tables bear a generic resemblance to those of Binet, and in actual practice the "standards" did win acceptance as a test of intelligence. The requirements were perhaps less scientifically determined than are those of Binet's tests, but their practical value was very much greater, because of the extremely wide range of their application.

When the codes had been in working order for a score of years it became evident to thoughtful observers that there had arisen a standard of comparison among pupils in elementary schools that was gradually being recognised all over the country. It was an objective standard as was shown by the fact that each of the standards began to have a meaning of its own, apart from the individual school in which a particular pupil happened to be found. No doubt there were differences in detail. A Standard III. boy in one school would be found to have greater knowledge and skill than a Standard III. boy in another. But the important point is that the phrase "a Standard III. boy" came to have a definite meaning apart from any particular school. It began to be used absolutely, and not merely relatively. Further, if a boy were found to be in a standard lower than his years warranted, people had no diffidence in drawing their own conclusions regarding his ability. It will be remembered that Binet tells us, somewhat vaguely, that if a boy is a year behind others of the same age who have had the same opportunities, it indicates that he is duller than the others, but not necessarily permanently so. If, however, the pupil is two years behind the normal test for his age there is a presumption in favour of his being inherently and permanently duller than his fellows. All this is very familiar and indeed commonplace to the elementary teachers who were brought up under the code examinations by standards. To tell the truth, M. Binet's tests are regarded with much suspicion by such elementary teachers as have been induced to give them attention. They have the feeling that here we have a university professor working out as something new a belated scheme that has had its day, and in that day done a great deal of damage. They are afraid that the prestige given to the intelligence tests may encourage the re-establishment of the rigid individual examination system from which they have escaped. All the same, experienced elementary teachers do not deny that the old system did at least have the effect of establishing a generally recognised standard. Their belief is that the standard was not worth what it cost.

It is left for Binet's successors to invent a better scheme than he was able to produce, and in this way to establish an objective standard, at least in respect of intelligence. Such a standard is needed in many connections, but there is one special department of educational administration where such a standard is at present urgently required. Nothing better illustrates the groping of education after a scientific basis than the present demand for some means of determining which children are "defective" and which merely dull. So imperative is the need for an objective standard here that it must be satisfied at any price, with the result that the decision is being more and more left to the doctors instead of to the teachers. The cause is not difficult to find. Physiology has already an objective standard, and the doctors are evidently expected to get their results by physical examination. No other explanation is admissible, since they are not only not superior to teachers in their knowledge of the mental reactions of the child, but obviously inferior. At present the argument moves backwards and forwards. Some say: Give the teachers a tincture of physiological knowledge, and then they will manifestly be the best persons to determine the defective stage. Others reply: Give the medical men some little experience of school conditions and the working of the immature mind, and they cannot but be the proper authorities on all questions of intelligence. The important point in this competition for power between the two professions is the implied recognition of the need for an objective standard, and the admission that, at present, such a standard does not exist. Much investigation, experimenting, and verification are necessary before the truth on this particular subject can be reached. But the recognition of the existence of the problem is in itself an indication of progress, and the need for scientific method in working it out is being more fully recognised. From our point of view it is important to note that we are here dealing with a problem that is distinctly educational, and the bringing in of men from another profession does not make it less so. If the doctor acquires the power of dealing with delicate questions of intelligence, it is because he has learnt to be an educationist if not an educator. Medical men who specialised in this matter would no doubt very soon attain to high skill, since their previous training gives them a very suitable preparation to begin the study of education. Doctors are consulted regarding "defectives" mainly for two reasons. First, these defective children are naturally classed in the popular mind with the mentally deranged, and these have always been regarded as peculiarly suitable subjects for the doctor. Further, there exists, without doubt, the implicit feeling in the public mind that the doctor has definite standards while the teacher has only general impressions. But it has to be noted that this invasion of the field of education by men from another realm of study does not in any way affect the claims of education to rank as a nascent science with needs and methods of its own. If the doctors can supply education with an objective standard, education should be very grateful, but need not abdicate in favour of medicine. Education may use the results of both psychology and physiology without in any way surrendering its claims to be an independent science. We must not, of course, make too much of the distinctions among the sciences. Nothing but error can result from seeking to make each of them rigidly self-contained. So far as education is concerned, what we have to seek is that objective standard that we have conceded to be essential to the recognition of a study as a possible science, and this without falling back on the standards of either pure psychology or pure physiology.

We may learn something from what we have found out about the results of the individual examination system. The general tendency of quantitative methods is to eliminate the subjective element. Even in the case of marking examination papers experience shows that the use of numerical marks tends to objectify results, and to get rid of some at least of the difficulty involved in the personal equation of the examiners. Marking by general impression of a whole paper is much less free from subjective variation. Every individual number set down as a mark implies a fresh exercise of the critical power, and when there are many questions there is a compensating principle at work, inasmuch as each impression is recorded as it is made and the addition of the marks produces a balancing in which the latest impression has not the determining influence it too frequently has when a paper is marked as a whole. If an examination includes many subjects, many examiners, and a great body of examinees, the subjective element in the marking is, to a large extent, eliminated, and we can deal with the results in accordance with what is practically an objective standard. We must not, of course, neglect the fact that after all the whole basis of the results is the judgment of the individual examiner on the material submitted to him. This corresponds to the application to real life of any of the physical sciences. Here, as in many of the other sciences, we have a surd of subjectivity that can never be got rid of entirely. But its disturbing influence can be minimised by the counteracting influences of other forces in the quantitative manipulation of the data.

Of late the quantitative method of dealing with educational problems has been greatly developed. Karl Pearson's product-moment formula has enabled us to make an accurate arithmetical statement of the amount of correlation that exists between series of quantitative data. By the application of this formula, and the simpler formulæ of Professor Spearman, it is now possible to correlate a great many facts that were formerly treated as having only a problematic connection with each other. If these formulæ produce really trustworthy results, we have at our command a means of answering definitely and definitively a great number of questions that have hitherto been regarded as the more or less legitimate matter for the professional controversialist. The vexed question of "formal training," for example, may be set at rest once and for all by a sufficiently extended series of correlations of the results of pupils' progress in certain subjects. The peculiarity of this method of dealing with correlations is that once we have handed over our facts to the formulæ, the process passes out of our hands altogether. We have only to work out our equations and the results make their appearance. Here we certainly seem to have reached an objective standard.

Such results, however, are not unnaturally regarded with some suspicion. Once the formulæ have been established by mathematical proof they must, of course, be accepted as irrefutable on that side; but their application to educational problems is so mechanical and indeed inhuman that many are unwilling to accept and use them. Some people are doubtful whether, in dealing with human beings, it is desirable, even if it were possible, to have an objective standard that eliminates humanity from all human problems. It has to be pointed out to such critics that all human problems must begin with the individual and end with the individual. All the intermediate process may be carried on in the pure objectivity of quantity, without dehumanising the application of its results. This will be kept in view when we deal with the average.

Apart from the danger of dehumanising our subject, there are two real possibilities of error in the application of the formulæ. First, there is the danger that the investigator may be satisfied with an application to an insufficient number of cases. The second danger is that the subjective element may cause error in the preparation of the data. If the first possible source of error be minimised, the second will be practically removed. Granted a really wide investigation, there is little room for serious error. If a sufficiently large number of cases be examined, and these cases selected under sufficiently varied conditions, the subjective variations will neutralise each other, and a trustworthy result will be produced. It must never be forgotten that the Pearson and other formulæ are merely means of dealing with material already acquired. It is only to this extent that they supply an objective standard. Many of the recognised sciences are in no better case.

The hope of the evolution of education as a science lies in the proper manipulation of the method of experiment. Students of education have always been in the habit of asking questions, but they have not always waited for an answer. Nor have they usually taken sufficient care in making their questions precise. They have not laid down with the necessary detail the conditions implied in the question, and when they have reached some answer they have been too often content either to accept it without any verification at all, or with the support of nothing but a few general considerations that seemed to confirm it. In the newer educational investigations questions are set out in great detail. They are usually limited to one point, and all the relevant conditions are carefully laid down. Various control tests are applied during the progress of the investigation, and every precaution taken against the introduction of interfering forces. Then when a result has been obtained various confirmatory tests are applied. Even when all has gone well so far the result is not regarded as authoritative until the experiment has been repeated with the same results by different experimenters working under different general conditions, though, of course, all the detailed conditions must be precisely the same as in the original experiment.

The questions asked are often of a very practical character. In the current number of *Child-Study*, Mr. W. H. Winch gives an example. The question is whether one gets better results in working "problems" in arithmetic by (*a*) direct teaching for a certain period in how to work such problems; or (*b*) spending the same period in giving the pupils practice in working such problems. Mr. Winch gives a very instructive account of all the conditions under which his experiment was carried out, including all the necessary precautions. The result is that those who had had the teaching scored an average of 11·1 in the final test, while those who had had the practice scored only 9·2: the group that was taught improving on its preliminary record to the extent of 34 per cent., while the group that had been confined to practice improved by only 11 per cent. It is thus demonstrated, at present, that teaching counts for more than practice in the preparation of pupils to do problems in arithmetic. But the fact cannot be regarded as a part of the permanent possessions of the teacher till it is verified by many more experiments in this country and abroad.

We have seen that even at our present stage of advancement there is quite a respectable collection of recognised facts in connection with teaching and education, and that these are in process of organisation. We shall soon have such a volume of well-arranged knowledge as shall meet the first requirement for recognition as a science. But while organisation is imperatively needed and must go on, there is an equally urgent need for new knowledge. There are hundreds of definite practical questions that are being asked by teachers every day, and unfortunately answered according to individual experience, if not indeed according to individual caprice. Some few questions about the memory are now definitely answered, and practical educators have the benefit of the results of experiments; but there are scores of points with regard to memory on which there is still doubt, and yet these are points on which the practical educator must adopt a definite line in his daily work. He cannot postpone his decision: he must do one thing or another, and in the meantime he has no standard. Such investigations as are being undertaken by the committees of this section are helping to increase the total body of knowledge at present available. It is true that hitherto these investigations have been mainly concerned with psychological matters, and certainly our store of psychological knowledge is not so great as to warrant any complaint at the concentration on this aspect. But it is pleasant to note that this year we are having a report on more distinctively pedagogic matters. There could be no more useful subject of inquiry suggested than an investigation into the questions that are most urgently demanding answers at this time among the practical educators of the country. To discover and classify these, and then to correlate them with the various investigations that are being made throughout the world, would be to render a very practical service to the study of education. The truths thus acquired and recorded could be fitted in to the mass already at our disposal, and the result would be a great strengthening of that objective standard that is so essential to the independent progress of our study.

Education ranks with a group of studies that deal with humanity in its various aspects. Psychology naturally is the science that underlies them all, since it is the abstract study of human nature which is their raw material. But politics, economics, sociology, eugenics, all claim to be sciences, and if we probe into their standards we find that they are largely statistical. It is quite possible by careful investigation among the subject-matter of these sciences to organise a system of general principles based upon averages obtained from a very wide field of investigation. These principles are of very general application, though they may not enable us to prophesy in individual cases. This, indeed, is at the root of a great deal of the criticism levelled at the claims of education to rank as a science. A parent or an education authority presents a boy to an educator and calls for a prophecy. The educator must decline, since he cannot honestly prophesy in an individual case, though he may be prepared to venture on a reasoned statement of what is likely to occur in the boy's educational career. The educator is, in fact, in precisely the same position as a medical man called in to a case. He can prophesy, but only in general terms. In both cases it is the application of general principles to a particular case.

This raises the whole question of the value of the average in matters of education. Psychologists, in addressing teachers, are beginning to warn them that the average is only an abstraction, and really does not exist. We are told that what the teacher has to concern himself with is "the living child here and now before him," and he is accordingly warned against the insubstantiality of the elusive abstract. But this is to confound two distinct things. It is true that the teacher must always deal with a living pupil here and now before him. But in his dealing with that living pupil he has to apply a paid-up capital of knowledge of men and of boys in general. He must seek to understand the living boy by the aid of knowledge previously acquired, and this knowledge is represented by the average. The master may be unable to prophesy with certainty how Jones minor will act under certain specified conditions. But from a knowledge of third form boys in general he can make a guess that is very likely to hit the mark. The teacher who applies his knowledge of the average third form boy to the minor Jones, without modification to suit Jones's case, acts unintelligently; but the possibility of blunders by a dull master does not reduce the value of the knowledge of the average in the hands of one who is capable. The concept of the average boy as it is developed by experience and study in the mind of the master forms a standard by which other boys may be estimated. This standard is partly subjective, partly objective. In so far as the standard is acquired by the personal experience of the master it is subjective. The unreasoned but very effective knowledge of boy nature that enables an efficient master who is guiltless of any acquaintance with educational theory to know how a boy is likely to act in given circumstances results from the training of experience, and is peculiar to its possessor. On the other hand, the knowledge of boy nature that has been acquired by deliberate study and by experiment is something that has an existence independent of the individual. It is objective, or at any rate has an objective bias.

We must distinguish in practice between the average and the type. The average boy may have no existence in reality, he may be a pure abstraction; but the type is concrete, and may be regarded as the embodiment of all the essentials that go to make up the average, with the addition of certain qualities that must be present in some form or other, though the particular form is immaterial. The average is to the type as the concept is to the generalised image. The type may form a very useful standard for masters whose tendency is strongly towards the concrete; but the average has a special and a different value, and in capable hands is more effectively applied because it is of a wider range. To consider a class as made up of types tends to break up the class feeling, and make the master think of his pupils as a mere group of separate individuals. Undoubtedly the master must in certain connections think of his pupils as individuals, but in other connections he must deal with his class as a whole, as a psychological unit.

This introduces one of the most striking developments of modern educational theory. The older psychologists treated their subject as limited to the study of the mature human individual. The introduction of the idea of development led to the founding of a genetic psychology with its consideration of the individual at his various stages. A further advance is marked by the appearance of collective psychology, which carries the study of the individual into his relations with other individuals. Naturally, both changes were of the greatest advantage to education. The first gave scientific guidance to the popular movement known as Child-Study, the second suggested the scientific study of the class as a collective organism. It is true that this collective psychology is at present in its infancy. But while we owe much to the French psychologists with their dazzling exposition, we are glad to turn to our more solid McDougall for the best scientific basis available for a sound collective psychology. The material he has supplied is waiting to be worked up from the educational side. His statement of the relation between the instincts and the emotions and his manipulation of Mr. Shand's theory of the sentiments provide tempting material for the establishment of an objective standard in connection with the training of the individual character and the interaction of individual characters in groups. Naturally, the results must be expressed in averages, and equally naturally there will be a complaint from certain practical educators. What is the use, it will be asked, of information about how classes in general act? What we want to know is how this particular class before which I stand is going to act. But this is to confound the practice of a science with the science itself. There must always be an intelligent intermediary between the principles of a science and their application to the affairs of life. In this respect the nascent science of education differs in no way from those that are more fully developed. The educator who prides himself on being specially practical is frequently very unreasonable in his demands from educational theory. He is rather apt to complain that it does not supply him with sufficiently detailed instructions. What he wants is a series of recipes which, if scrupulously followed, will inevitably produce certain specified results. But such men take a very humiliating view of their profession. So far from seeking this spoon-feeding, they should rejoice that their work demands the exercise of intelligent initiative. Herein consists, in fact, the dignity of the educator's office. He must be master of the organised knowledge that education has acquired, and must have the power of making the appropriate application of that knowledge to every case as it arises. To assist him in avoiding error he is entitled to look for an objective standard at the hands of those who make education their special study, but for the use of that standard he must himself accept the full responsibility.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE proceedings of the Geological Section at Dundee were of exceptional interest, and the attendances were large up to the end of the meeting. The success of the section was due to two or three special features. Many of the papers dealt with the problems of the Highlands and of the Highland border, questions which are full of knotty points, and the men who are engaged in solving these problems were able to assemble in the meeting-room and there state their views and face discussion, which was often very lively and always full of vigorous earnestness. Then we had a commodious and quiet meeting-room, and the President (Dr. B. N. Peach) was a host in himself. As Dr. Heim said, in seconding a vote of thanks to him: "When I look in front I always see the sun," and the vivacious countenance and stirring enthusiasm of Dr. Peach were an incentive to all present to rise to their best.

After the delivery of the President's address on "The Relation between the Cambrian Faunas of Scotland and North America," which was a timely and most valuable deliverance giving the evidence for the land connection between North America and North-west Europe in Cambrian times, a lecture was delivered by Dr. T. J. Jehu on the local geology. After a brief reference to the exposures of the Highland Boundary series in Forfar and Kincardine, and to the recent discoveries of rocks of Downtonian age near Stonehaven, the lecturer dealt with the groups of rocks found in the area:—(1) The Highland metamorphic rocks; (2) the Old Red Standstone; (3) the Carboniferous system of Fife.

(1) The prominent series of metamorphic rocks comprises the Dunkeld slates, schistose slates and micaceous grits included in the Ben Ledi group. With the schists are associated the "Green Beds" of the Geological Survey and certain basic intrusions mapped as hornblende schists.

(2) Two divisions of the Old Red Sandstone are represented, Lower and Upper, separated by a marked unconformity. They consist of two sedimentary groups separated by the great volcanic series of the Sidlaws and the Ochils. The distribution and characteristics of the volcanic beds were described, and the probable positions of the vents from which the materials were ejected were indicated. The Lower Old Red Sandstone rocks were folded and denuded before the deposition of the Upper Beds, which pass conformably up into the Carboniferous System in Fife.

(3) The Carboniferous rocks of Fife consist of the Calciferous Sandstones at the base, overlaid by the Carboniferous Limestone series, which are overlaid by Millstone Grit and Coal Measures. Special attention was directed to the splendid development of workable coal-seams in the middle group of the Carboniferous Limestone series, as well as in the Lower Coal Measures of the district. The remarkable diversity of igneous rocks and the great development of volcanic rocks on the coast of Fife were described, and were subsequently displayed to the members by a field-excursion to Elie.

During the meeting various problems connected with the Pre-Cambrian rocks of the Highlands and the Highland border were thoroughly expounded and discussed.

Mr. E. B. Bailey described the occurrence in eastern Mull of a great breccia-formation with intercalated rhyolitic lavas. The breccia consists of an unbedded assemblage of blunted rocks and fragments of gneiss, granophyre, gabbro and basalt, often associated with rhyolitic *débris* of volcanic origin. The basalt lavas of Mull have been violently folded into a series of anticlines and synclines, and it is in one of these synclines that the main outcrop of the breccia is preserved. It appears that the breccia is a thick layer overlying the basalts and folded with them. Though some parts of the breccia may be of volcanic origin, Mr. Bailey suggests that the greater part has resulted from erosion, which operated during the period of upheaval of the ridges.

Dr. J. S. Flett opened a discussion on the sequence of volcanic rocks in Scotland in relation to the Atlantic-Pacific classification of Suess. He pointed out that the recognition of two great families of igneous rocks, the Atlantic and the Pacific, and their relation to certain types of earth-movement, which we owe to Mr. Harker, constituted one of the greatest advances in rational petrology. In Scotland the Carboniferous volcanic rocks are typical Atlantic types, associated with collapse and great faults, and the rocks of Lower Old Sandstone age are characteristic of the Pacific group (great crumbling). To the Atlantic group could be added the Permian or late-Carboniferous rocks of Ayrshire and East Fife, and the nepheline-basalts (presumably Tertiary) of Caithness with their associated camptonites and monchequites. The Tertiary volcanic rocks of the Hebrides and the abundant north-west dykes were also ascribed to movements of Atlantic type. The remaining rocks of Scotland Dr. Flett desired to assign to an independent, intermediate group. They are characterised by pillow-lavas and are not connected with movements either of the Pacific or the Atlantic kind, and may thus be placed in a special family.

Dr. Flett's address was followed by a vigorous discussion, in which considerable criticism was expressed of the terms Atlantic and Pacific, and especially of their application to types of rocks in Scotland; but Dr. Flett pointed out that some terms must be used, and these were convenient, but he was not pledged to them in any way. Dr. J. W. Evans (London) thought that Dr. Flett had made out a *primâ facie* case, so far as the Scotch volcanic rocks were concerned. He believed that the first differentiation of igneous rocks was a result of the separation of the original magma, on cooling, into two fluids, one consisting mainly of water, silica, alumina and alkalies, the other made up chiefly of magnesia and ferrous oxide with sufficient alumina and silica to form anorthite and the ferric minerals. Subsequent differentiation was principally due to crystallisation. In folded areas the segregation took place at a considerable depth, while the magma still retained its original aqueous contents. The primary differentiation was therefore comparatively complete, and the normal or "Pacific" series of rocks was ultimately formed. In districts of plateau faulting, on the other hand, the differentiation occurred nearer the surface and under conditions which facilitated the loss of water, so that the separation was imperfect, the basic portion retaining more silica and a considerable amount of alkalies, and subsequent segregation by crystallisation gave rise to the alkali or "Atlantic" series. He also suggested that the occurrence of sodium with the basic rocks might be due to the presence of an unusual amount of chlorine, which separated out with the basic constituents and brought the sodium with it.

Dr. Tempest Anderson did not agree with the suggestion that pillow-lavas had been formed in deep water, and gave instances which he had seen of their formation by lavas flowing into shallow waters, and apparently due to sudden cooling by the waves. Mr. G. W. Tyrrell (Glasgow) much preferred the terms "alkalic" and "calcic" for Dr. Flett's main divisions. The differences were mainly chemical and mineralogical, not geographical. Many group names cover a wide diversity of types, and we appreciate the great value of Dr. Flett's recognition of mono- and poly-phyletic rocks, that is, types highly characteristic of one group only and types to be found in all the main divisions of igneous rocks. Dr. Hatch pointed out the advantage of a division which recognises a well-defined suite of rocks in which the alkali and calc-alkali felspars are developed in equal proportions, a series to which Brögger has given the name Monzonite series, and hoped that such a classification would be generally adopted.

Mr. G. Barrow gave a valuable paper on the older granite in Lower Dee Side, in which he showed that in place of forming large coherent masses, it was distinguished by *lit-par-lit* intrusions. The granite material in these cases formed minute sills parallel to the foliation of the associated gneiss into which it had been intruded. The granite rises as a dyke and the sills diminish in thickness and extent as they near the surface. In the interior parts the granite is usually grey and contains more biotite than muscovite, and oligoclase is usually abundant. The oligoclase and biotite are found to diminish steadily as the rock is traced towards the taper end of the sills. At this point there is little oligoclase and often no biotite; muscovite is fairly common and the bulk of the felspar is of alkaline composition. It would appear that the fissures in which the dykes occur were filled with igneous material, and that under great pressure the walls were burst open and the still liquid material forced out, and thus separated from that which had already become segregated. This phenomenon may be described as magmatic differentiation intensified by dynamic action. Mr. Barrow also read a paper on buckled folding. Descriptions have been published of areas of regional crystalline metamorphism in which the dip of the bedding is described as at a low angle over a considerable area. Experience is gradually proving that these altered sediments are always intensely folded, and the low dips really represent the most complicated structure, for which the name "Buckled Folding" is suggested. This structure is best seen in the Moine Gneisses, and its development can be studied in the cliff sections between Stonehaven and Muchalls. The grits and shales on the limb of the folds, near Stonehaven, ascend the cliffs in an unbroken course from bottom to top, being isoclinal and unbent. But as we proceed northwards the course of the grit bands up the cliff face is no longer straight, but a small overfold, or "buckle," is developed in it. At first only one is seen in the whole height of the cliff, then two, then three, and so on, until they are so close together that the still straight portion of the fold is no longer than the "buckled" or overfolded portion. If the upward course of each grit band be followed, it will be found that this structure does not alter the dip of the band as a whole. It still descends at much the same angle, but by a zigzag course. The overfolds all face in the same direction right up to Muchalls, and must have been produced after the isoclinal folding was completed. There is no justification for separating the buckled beds from those in which buckling does not occur. A key to the connection is found in the area about Shiehallion, where the quartzose beds forming the margin of the quartzite and containing the boulder bed and the limestone show isoclinal folding; whereas further north the same group comes on again, but this time with buckled folding, or Moine gneiss.

Dr. B. N. Peach and Dr. J. Horne described some interesting investigations which they had recently made on the Archæan rocks of Lewis, in which they showed how closely these beds corresponded to the rocks of the adjoining mainland, without the great series of acid intrusions. The structure is coarsely granulitic, and there is a marked absence of the pyroxene-gneisses with blue quartz, of pyroxene-granulites, and other basic forms, which are so characteristic of the mainland. The remarkable series of basic dykes in the west of Sutherland had not been detected in Lewis. The north-west and south-east strike, referred to by Murchison, was not characteristic of the gneisses of Lewis. The dominant strike is almost north and south, but north-east to south-west or east to west in other areas. The flaggy granulitic gneisses of the Butt of Lewis, which appear to run southwards along the belt of high ground between Stornoway and Barvas, resemble closely the Moine gneisses east of the Moine thrust-plane, but they differ petrologically from the rocks of sedimentary origin which form the Moine series. The system of overfolding and the direction of the axial planes of the folds approximate to those found in the Moine rocks on the mainland. The platy rocks, or mylonites, occur along definite lines of movement approximately north to south, and thrust-planes have been detected which point to displacement in a westerly direction. Various stages in the development of mylonites from the acid and basic gneisses are represented. In the discussion which followed the value of these investigations was emphasised by Dr. Flett and others.

Important discoveries of fossils in old rocks were announced by Dr. R. Campbell (Edinburgh) and Prof. T. J. Jehu (St. Andrew's). Dr. Campbell described fossil remains found in the Jasper and Green Schist series of the Highland border, at Craigeven Bay, Stonehaven. Crushed spilitic lavas with intercalated black shales, jaspers, and cherts, which in their lithological characters resemble closely the green igneous rocks and associated sediments along the line of the Highland fault, appear on the old Geological Survey maps as of (?) Arenig age. In 1909, in company with Dr. Peach and Dr. W. T. Gordon, the author found several fossils in the black shales. Detailed search by Mr. D. Tait revealed fossils of the forms Lingulella, Obolella, Acrotreta, Linnarssonia, and Siphonotreta; a bivalve phyllocarid allied to Caryocaris and Lingulocaris; and cases of a tubuloid worm. The above genera are most commonly found in the Ordovician beds and in the Upper Cambrian, but, owing to the absence of graptolites, Dr. Peach suggested that Upper Cambrian was the most probable age. Whatever may be the ultimate decision as to their stratigraphical horizon, the discovery of these fossils leaves very little doubt that the boundary fault series is *not* pre-Cambrian.

Dr. Jehu followed this paper by one on the discovery of fossils in the boundary-fault series, near Aberfoyle. This series is well exposed between Loch Lomond and Callendar, forming a narrow belt separated by a reversed fault from the Lower Old Red Sandstone on the south-east, and probably by a line of thrust from the Leny Grits on the north-west. It consists of black and grey shales, cherts, grits, and calcareous beds. Remains of Radiolaria were discovered by Dr. Peach some years ago in cherts near Gualann. Recently a number of fossils have been found in pale-grey chert bands near Arndrum. These fossils occur in muddy films in the chert belt. They are almost all hingeless brachiopods, and the following forms have been determined by Dr. Peach:—Acrotreta, Lingulella, Obolus, Obolella; also the flattened chætæ of polychæte worms. These fossils were regarded as indicating an Upper Cambrian age. Dr. Horne, in the discussion, regarded the collection of fossils from the chert and green-schist series at Stonehaven and Aberfoyle as the most important palæontological "find" affecting Highland geology since the discovery of Olenellus in the west of Ross-shire. The strata containing these fossils, which had been provisionally referred to the Upper Cambrian by Dr. Peach and Dr. Walcott, could no longer be considered as of pre-Cambrian age, like those of similar rocks in Anglesey. At a subsequent meeting Dr. Horne read a letter from Dr. Ami (Toronto), who had examined Dr. Jehu's collection of fossils from Aberfoyle, and found them closely resembling those obtained from Upper Cambrian beds belonging to the Quebec group. His opinion was based partly on the brachiopods and partly on the occurrence of an obscurely preserved graptolite resembling *Retiolites ensiformis*, Hall—a type eminently characteristic of the Sillery Sandstones of the Quebec group of Upper Cambrian age. Dr. Horne further stated that this form had been shown to Miss Ellis (Cambridge), who recognised it as a graptolite with Ordovician affinities.

Dr. A. W. Gibb (Aberdeen) read a paper on an actinolite-bearing rock allied to serpentine associated with the basic intrusion of Belhelvie. Towards the northern end of this mass, which consists of troctolites, serpentines, and allied types, there is a rock which shows a large number of dark-green rounded spots, set in a fine felt of paler green colour, full of glancing needles. Under the microscope the spots are seen to represent olivine, partly unaltered, partly serpentinised, as well as granulitised and drawn out. The rest of the rock is largely made up of actinolite in small crystal flakes, and green spinel and abundant magnetite are present. The exposure has recently been blasted away.

Dr. Wm. Mackie described the volcanic rocks round the Ord Hill of Rhynie, Aberdeenshire. The group embraces at least three lava flows, with associated tuffs and interbedded and overlying sedimentary rocks. Flow brecciation is frequent, and the tuffs are rhyolitic. The sedimentary rocks of the group consist of hard siliceous grits, which, under the microscope, show volcanic fragments. The whole of the group is characterised by fine, secondary quartz infiltration veins. They overlie the basic rocks of the younger Grampian granite series, but are probably considerably older than the oldest Old Red beds of the adjoining area. The lavas, being of an acid type, cannot be correlated with the interbedded andesites of the Old Red Sandstone.

Mr. G. W. Tyrrell (Glasgow) described the alkaline igneous rocks of Ayrshire. Recent work of the Scottish petrologists shows that one of the greatest developments of rocks characterised by primary analcite is contained in the midland valley of Scotland, one centre being in Ayrshire, the other in the area surrounding the Firth of Forth. Geologically these analcite rocks are Carboniferous in age, having a time-range from Carboniferous Limestone to Early Permian. They occur in the form of stratiform sills, lenticular intrusive masses, volcanic plugs, and as a series of lava flows. No masses of true plutonic habit are known.

Passing to Wales, a paper was read by Mr. Edward Greenly on the origin of some of the mica-schists of Anglesey. The mica-schists of southern and central Anglesey are holocrystalline rocks with strong parallel structure, and composed essentially of quartz, alkali-felspars, and white mica. Dr. Teall regards them as broken-down and partially reconstructed porphyritic felsites. Twenty-five years ago Dr. Callaway recognised their felsitic origin, which the present investigations confirm. These schists, therefore, may be looked upon in general as derived from acid igneous rocks. In some areas mica schists in continuity with them are found in intimate relations to schists of sedimentary origin, so that, probably, pyroclastic material was present in the original igneous series.

Dr. Robert Campbell (Edinburgh) gave a valuable *résumé* of his recent investigations on the Lower Old Red beds of Kincardineshire, showing that a thickness of 3000 ft. ought now to be transferred to the Downtonian, the uppermost group of the Silurian system. At the base of the series near Stonehaven there is 200 ft. of breccias interbedded with fine red mudstones made up mainly of fragments of the underlying (?) Upper Cambrian rocks, and resting unconformably on them. Near Cowie Harbour there occurs a thick belt of grey and greenish mudstones which yield Dictyocaris in abundance. Ceratiocaris, Archidesmus, Eurypterus, and other forms have been obtained from the same horizon, and in another bed numerous plates of a new Cyathaspis have been found. These interesting fossil finds, which in other areas do not occur in rocks younger than the Upper Silurian, and the lithological characters recall the typical Downtonian of the south of Scotland. These beds pass upwards into the micaceous sandstone and conglomerates of Stonehaven Harbour, which may be considered as the base of the Lower Old Red Sandstone. The fish remains were examined by Dr. R. H. Traquair, who reported that the small scutes were referable to the category of Cephalaspidian scutes, that the species to which they belong is pretty certain, but additional material is required before proceeding further with identification. He described several specimens of a beautiful new Cyathaspis, which he dedicated to Dr. Campbell.

Mr. C. J. Gardiner gave an account of the Silurian inlier of Usk. It is an oval area, eight miles by four, crossed by an important east and west fault. The southern half is composed of two anticlines separated by a fault. The axes of these folds run north and south, and dip southwards. The western anticline is the larger of the two, and shows Wenlock Shales and Limestone and Ludlow beds. The northern half of the inlier is far less simple than the southern in its structure, and is more concealed by drift. The Wenlock Limestone is not met with in this half. The simplest explanation is that the Wenlock Shale is faulted against the Ludlow beds on both sides. As the Aymestry Limestone is absent from the area, it is impossible to separate the Ludlow beds into an upper and lower division. The main boundary faults are crossed at several spots by minor east and west faults which cause small lateral displacements.

There were three important contributions from the palæobotanical side. Dr. Marie C. Stopes gave an outline of a controversy in New Brunswick between the palæobotanists and the stratigraphers. In the "Fern Ledges" of St. John there is a rich fossil flora, but no animal remains. Sir W. Dawson described the plants as Devonian. Recent attempts have been made to include the beds in the Silurian for stratigraphic reasons. The author's work in the field indicated considerable overthrust. The unique series had recently been redetermined. Type specimens had been lent by the Canadian museums and brought to London and Paris for comparison, resulting in the identification of a large proportion of well-known European types in the "Fern Ledges" flora as Carboniferous and mostly typical of the Westphalian division of the Coal Measures.

Dr. W. T. Gordon read a paper on the fossil flora of the Pettycur Limestone in relation to botanical evolution. The flora of the Pettycur Limestone (Lower Carboniferous) has a double interest. These forms constitute fragments of the oldest known flora, as Lower Carboniferous plants do not differ markedly from the Upper Devonian forms. Although the Devonian flora is distinct from that of the Permo-Carboniferous epoch, yet the organisation does not indicate that the plants were primitive. The result of Dr. Gordon's investigations was that the flora represented in the Pettycur Limestone appears, on the whole, to contain more generalised and simpler types than occur in the Coal Measures and later strata, and these types may be arranged in order so as to suggest certain possible lines of evolution.

Mr. W. R. Don (Dundee) read a paper on the nature of *Parka decipiens*. This fossil is the only common and quite the most characteristic fossil of the Lower Old Red Sandstone of the Kincardine-Forfar-Perth area. A re-investigation, chiefly microscopical, has been attempted with the aid of Schultz's solution (strong nitric acid and potassium chlorate). Most previous investigators had pronounced it to be vegetable, though Mantell, Lyell, and others considered it as an egg-packet of Pterygotus. The conclusions of the author were confirmatory of those of Sir W. Dawson and Prof. Penhallow that it was vegetable, and after boiling in nitric acid, the presence of spores within the carbonised tissue was demonstrated. In attempting to form some conception of the original structure and shape of Parka, the author concluded that the original spore-containing tissue was almost flat, not spherical, and unlike any known sporangia of to-day. There was, certainly, intimately connected with it a so-called "indusium." In the discussion, Dr. G. Hickling stated that his independent observations on Parka were in very close agreement with those of Mr. Don. He questioned, however, the nature of the cells, hitherto regarded as spores, and preferred to consider them as constituting simply a parenchymatous mass. These masses possibly served as reproductive buds analogous to the gemmæ of the Hepaticæ. Dr. Newell Arber (Cambridge) remarked on the extreme interest of Mr. Don's careful work on Parka, and was quite prepared to allow that the organs termed spores were undoubtedly of that nature. He differed from Dr. Hickling's criticisms, and pointed out that if these bodies were not spores, but parenchymatous cells, they certainly could not have survived the extremely severe chemical treatment to which they had been subjected. Dr. Hickling appeared to have examined chiefly spore sacs in which the spores were not yet mature, a condition also commonly noticed in some of Mr. Don's specimens, and this appeared to have been the chief basis of his criticism. Dr. Arber agreed with Mr. Don that Parka was undoubtedly a member of the Thallophytæ, and very possibly an alga.

The first results of investigations on the contents of the Millstone Grit of Yorkshire were communicated by Mr. Albert Gilligan (Leeds). Following up the work of Dr. Sorby, the late Mr. A. Longbottom had collected some very large pebbles from the Middle Grits of Silsden. These had been examined by the author, who had extended his researches to other beds of the series in Yorkshire. Some of the pebbles were of considerable size and showed a remarkable assemblage of rocks. By far the most common were acid igneous rocks. Only one specimen of a basic igneous rock had been found. The metamorphic rocks were quartz-schist and mica-schist, with a few fragments of gneiss. Numerous pebbles were found to be perfectly fresh microcline. Pieces of pegmatite were common. Some fragments obtained from the Plompton Grit proved to be a peculiar silicified oolitic rock. A few pebbles showed traces of organisms such as sponge spicules. The heavy minerals of the grits were not numerous, zircon and garnet being the most plentiful. The felspars in the grit were quite fresh, and this suggests either disintegration of the parent rock by differences of temperature and rapid transportation, or comparative absence of carbonic dioxide in the atmosphere. The author had been much impressed by the many points of similarity between the Millstone Grit and the Torridon Sandstone, and was disposed to think that areas of similar rock types were laid under contribution for each.

Mr. T. O. Bosworth gave an account of some investigations into the heavy mineral grains in the sands of the Scottish Carboniferous. The chief heavy minerals found were garnet, zircon, magnetite, tourmaline, rutile, staurolite, anatase, barytes. The sands containing an extraordinary amount of angular garnet were probably derived from the Highland schists of the north and north-west. The sands devoid of garnet probably came from the north-east, east, or south.

Mr. J. S. Owens communicated the results of some experiments on the settlement and transport of sand in water. It was shown that there is a definite relation between the rate of settlement and the temperature of the water. The curves show that velocity of fall varies almost with the water temperature, the rate being always increased by rise of temperature, but that as the diameter of the grains increases the temperature effect becomes less, until for grains more than one-tenth inch in diameter the effect is practically negligible.

Mr. Edward Greenly contributed a theory of the Menai Strait, in which he accepted Ramsay's view of the Strait as a glacial furrow, but the middle of the Strait cannot be explained in that way. Evidence was adduced to show that this reach was excavated by glacial waters during the recession of the ice at a time when the mutual relations of the ice of the mountain land and of the sea-basin admitted of the accumulation of a temporary lake. Post-glacial erosion and subsequent changes of level have completed the bed of the Strait as it now exists.

The origin of kopjes and inselberge was dealt with by Dr. J. D. Falconer. It had been suggested that a landscape with inselberge was of desert origin, but the various phenomena could be explained more readily as the result of weathering and erosion during successive small oscillatory movements of a regional character in the neighbourhood of base-level.

Mr. G. W. Grabham gave notes of an exploration of the country north of Lake Albert. This area extends west from Rejaf to the watershed and southwards as far as the lake. It is entirely composed of gneisses, which are for the most part affected by a north-south foliation. The only member of apparently sedimentary origin consists of a band of quartzite which is traceable for some distance. Among the gneisses, a group characterised by graphitic pegmatite was recognised. Some intrusions occur among these gneisses, and form the only intervening link in time between them and the surface deposits. In the country north of Lake Albert extensive deposits belonging to an extinct lake were found. Lake Ismail, as it is proposed to call this lake, stood about 600 ft. above the present river-level, and its site is marked by gravels and beds of clay. Its limits are uncertain, but it did not extend into the area now occupied by Lake Albert. In later times the crust fractures of the Rift Valley occurred, and the present lake and river system was initiated. In more recent times still the river has again been modified by crustal movements.

The usual grants were recommended for the continuance of committees of research, and a new committee was formed to investigate the fish beds of Dura Glen. The meeting was attended by a large number of foreign geologists, who took an active interest in the discussions of the section. Among them were Prof. C. Barrois (Lille), Dr. Tschernyschew (St. Petersburg), Prof. A. Heim (Zurich), Dr. H. Reusch (Christiania), Prof. J. Welsh (Poitiers), Prof. E. Trietze (Vienna), Dr. Pirrson (Yale), Dr. Leith (Wisconsin), Dr. Ami (Toronto). The annual geological dinner was held at the Royal Hotel on Friday evening (September 6). Dr. Peach made a most genial chairman, and delighted the audience by rendering the "Song of the Seraphim," specially written for the Red Lion Club dinner held during the Dundee meeting in 1867, and then sung by the author, Dr. Henry Woodward, to the tune of "Bonnie Dundee." The menu card was graced by a photographic copy of the picture of Sir Charles Lyell painted in 1870 by Lowes Dickenson, when Sir Charles was seventy-three years of age. The picture was on view in the loan collection. Dr. Jehu and his assistants arranged three enjoyable excursions for the afternoons, and a whole day to see the wonderful coast sections of Carboniferous puy eruptions near Elie. At the close of the meeting two extended field excursions were arranged, one to Loch Assynt, under the leadership of Dr. Peach and Dr. Horne, and another to the country between Aberdeen and Arbroath, under the leadership of Mr. Barrow, Dr. Campbell, and Dr. Hickling. These were very enjoyable and instructive, and proved great attractions to the foreign geologists and a large number of their British *confrères*.

W. LOWER CARTER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The John Winbolt prize has been awarded to R. V. Southwell, of Trinity College, for an essay on "The Failure of Thin Tubes by Instability or Secondary Flexure."

BIRMINGHAM.—During the winter and spring terms two courses of lectures on "Civic Design and Town Planning" are to be given, by Mr. Raymond Unwin, in the department of civil engineering.

The following appointments have been made:—Mr. C. Walker as lecturer in physiology; Mr. Laurence Ball as assistant lecturer in pathology and bacteriology; Mr. P. M. Chadwick, assistant lecturer and demonstrator in civil engineering; Mr. A. Clubb, demonstrator in mining (as successor to Mr. C. D. Mottram); Mr. H. I. Coe, assistant lecturer and demonstrator in metallurgy. Mr. Percy May has resigned his post as assistant lecturer and demonstrator in chemistry, and Mr. Frederick Challenger has been nominated to the vacancy.

A COURSE of free lectures to teachers on "The Past Around Us," a series of brief studies introductory to the folk-culture of Britain, is being given by Mr. Walter W. Skeat, at the Horniman Museum, Forest Hill, S.E., on Saturday mornings, from October 12 to December 14. Admission is by ticket only, to be obtained from the Clerk of the London County Council.

LECTURES on volcanic action, earth movements, the geological action of water, and the evolution of scenery and life on the globe are to be delivered by Dr. Werner Marchand on October 17, 24, and 31, in the meeting rooms of the British Esperanto Association, 133 High Holborn (Museum Station Buildings), W.C. They will commence at 7.30 p.m., and will be delivered in Esperanto.

THE winter meetings of the Child Study Society begin this evening at the Royal Sanitary Institute, when Dr. T. P. Nunn will lecture on the psychological development of the school subjects. The list of lectures and discussions to be held this year provides many subjects of interest to students and teachers concerned with the education of children. Particulars as to membership may be obtained from the honorary secretary of the society, Mr. W. J. Durrie Mulford, 90 Buckingham Palace Road, London, S.W.

THE University College (London) Committee will shortly proceed to fill the vacancy in the Quain studentship in biology which has been created by the resignation of Mr. E. J. Salisbury, on his appointment as lecturer in botany at the East London College. Any student of the college is eligible for the studentship who has for at least three terms attended one or more classes in the special study in respect of which the studentship is awarded. Applications should be received on or before Saturday, October 26.

FOR some time articles have been appearing at regular intervals in the Journal of the Department of Agriculture and Technical Instruction for Ireland describing recently established Irish technical schools. These articles have been published afterwards as separate pamphlets for distribution by the department. The twelfth and thirteenth contributions to the series have been received in booklet form. The former is called "Technical Instruction in Limerick," and has been written by Mr. J. Comerton, the principal of the Limerick Technical Institute; the other deals similarly with Cork, and is by Dr. John H. Grindley, principal of the Crawford Municipal Technical Institute, Cork. The accounts of the work done in technical education in these important Irish industrial centres provide excellent evidence of the success which is attending the department's efforts to meet the educational needs in different parts of Ireland.

THE distinguishing characteristic of the calendar for the present session of the City of Bradford Technical College is the excellent series of thirty plates, which chiefly illustrate the very complete arrangements made for the practical study of the branches of technology on which the industries of the district depend. This college awards certificates, diplomas, and an associateship. The diploma of the college is awarded to each day student who has been in attendance for three complete sessions, subsequent to passing an entrance examination, and has passed the college examinations in all subjects of the diploma course taken. The diploma is awarded to evening students under the same regulations as to day students, except that an evening student who has been at least three years in attendance, and has obtained the ordinary certificate, is exempt from the first-year diploma course. To become an associate a candidate must be twenty-one years of age and have had at least one year's practical experience with a firm engaged in his trade or profession, subsequent to obtaining the diploma. Some of the subjects in which diplomas may be obtained are: preparing, combing and spinning, weaving and cloth structure, chemistry and dyeing, and power production and transmission.

ON Wednesday, October 9, at Bradfield College, Berks, a new block of science rooms was opened by Sir William Osler, F.R.S. A large proportion of the boys at the college have studied science during the last twenty years, and some fifty to seventy pupils work in the mechanical shops added in 1898. The new science schools have this year been added to deal more effectively with the growing demand, and mainly through the efforts of the present headmaster, the Rev. H. Costley White. Among the assembly present at the ceremony were the warden (Mr. Edward Armstrong), the Right Hon. G. W. Palmer, Mr. R. Dyke Acland, K.C., Sir Arthur Rücker, F.R.S., and Mr. J. H. Benyon. Sir William Osler, in a speech after the ceremony, dwelt on what he considered to be an ideal education for those suited to and seeking scientific pursuits in after life. He would have a thorough knowledge of Latin and Greek; he believed in the optimistic Greek outlook on life for boys; during his last two years the boy should specialise in science, which should occupy most of his school hours. The speaker objected very strongly to the use of the term "stinks" as applied to science study. He said that that one word had done more harm in implying discredit to, and in keeping back pupils from the study of, the subject than any other factor. The new science block is detached from the rest of the school buildings, and has an attractive exterior. The entrance lobby leads into two chemical laboratories on the right and two physics rooms on the left, each easily accommodating twenty boys. In the chemical laboratories each room is adequately fitted with fume cupboards, balance slabs, and store cupboards, and has a raised demonstration bench at one end of the room. The two physics rooms are each supplied with three central tables and side benches round the walls, balance slabs, and large sinks. Behind the entrance lobby is a lecture-room with raised tiers to accommodate fifty boys, with a demonstration bench, fume cupboard, and lantern screen. The architects are Messrs. Steward Smith and Hutt, of Reading, the builders Messrs. Hughes, of Wokingham, and the furniture has been supplied by Messrs. Baird and Tatlock.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 7.—M. Lippmann in the chair.—Maurice **Hamy**: An arrangement of the arc with iron electrodes working with alternating currents. The spark spectrum of iron, used as a comparison spectrum, presents difficulties owing to the variations caused by slight changes in the experimental conditions. The arrangement of the arc between iron electrodes described in the present paper was designed to replace the spark as a source of the iron spectrum.—Gustave **Sannia**: The simple characteristics of partial differential equations with two variables.—N. **Saltykow**: The theory of partial equations.—U. **Cisotti**: The movement of a solid in viscous liquid.—E. **Mérigeault**: The influence of the velocity of combustion on the efficiency of a gas motor.—V. **Auger**: A new volumetric method for the estimation of uranium. The solution is reduced with metallic zinc and titrated with a standard solution of a ferric salt, using ammonium thiocyanate as indicator.—Paul **Gaubert**: The polychroism of crystals of potassium sulphate artificially coloured.—Marcel **Mirande**: The presence of hydrocyanic acid in *Trifolium repens*. The presence of hydrocyanic acid, or of a substance giving rise to it under the action of an enzyme, was proved in the stems and leaves of this plant. None was found in the roots.—C. **Dhéré** and W. de **Rogowski**: The absorption of the ultra-violet rays by α- and β-chlorophyll and by crystallised chlorophyll. Pure chlorophylls are remarkably transparent for the ultra-violet rays.—Léopold Le **Moult**: The destruction of certain Hemiptera by vegetable parasites.—M. and Mme. Pierre **Delanoë**: The relations between the cysts of Carini of the lung of the rat and *Trypanosoma lewisi*. The authors conclude that the pneumocysts of Carini represent a new parasite of the rat; they are not connected with *Trypanosoma lewisi*.—E. **Foëx**: The "Fibrinkörper" of Zopf, and their relations with the metachromatic corpuscles.

NEW SOUTH WALES.

Linnean Society, August 28.—Mr. W. W. Froggatt, president, in the chair.—G. I. **Playfair**: The plankton of the Sydney water-supply. The Sydney water-supply is the water of the Nepean and Cataract Rivers, which is impounded in the Cataract Reservoir, and thence brought down, by many miles of canal, through the Prospect Reservoir to Guildford and Pott's Hill, where it is filtered by being passed through a double series of wire screens. These screens being periodically raised and washed with a hose, the effluent from this operation has been the principal source of the material studied.—Allan R. **McCulloch**: Descriptions and figures of three young specimens of sunfish (Molacanthus) from the Central Pacific Ocean. The specimens described were received by the trustees of the Australian Museum from Dr. Thomas D. Liddle, R.N. They are only 9·5-13 mm. long, and were taken from the stomach of a kingfish caught swimming near the surface during the passage of H.M.S. *Torch* between the Ellice and Union Islands, Central Pacific, in 1911.—H. J. **Carter**: Notes on Stigmodera, with descriptions of new species and of other Buprestidæ. Eleven species of Stigmodera are proposed as new, comprising five from West Australia, four from Queensland, one from New South Wales, and one from Victoria. Two species of Neocuris and one of Curis, all from Queensland, are also described.

CALCUTTA.

Asiatic Society of Bengal, September 4.—L. L. **Fermor**: Preliminary note on the origin of meteorites. As the result of investigations into the conditions of formation of garnets, especially with respect to pressure, the author has been led to postulate the existence, below the plutonic rocks of the earth's crust, of a zone of rocks characterised by the abundant presence of *garnets*, the garnets being the result of the high pressures (and temperatures) existing in this zone. For this zone the author proposes the term *infraplutonic*. Armed with the conclusions thus obtained with reference to terrestrial rocks, the author proceeds to the consideration of meteorites, in particular of the stony forms known as aerolites; he is able to offer an explanation of the round bodies known as *chondrules*, so characteristic of many stony meteorites; he shows that each chondrule was once a garnet, and that the rock now represented by the chondritic meteorite must have been a garnetiferous eclogite situated at a considerable depth below the surface of some primeval stellar body. The disruption of this body was accompanied by a sudden reduction in pressure, which caused the garnets to liquefy with increase of volume. The rapidly decreasing temperature after this disruption caused the rapid crystallisation of these liquid drops with formation of the radiate and other crystalline aggregates of enstatite and olivine (sometimes with glass) so characteristic of chondrules. Starting from this interpretation of the chondritic meteorites the author is able to refer each of the great groups of meteorites to their respective positions in the primitive stellar body before disruption.—Anukul Chandra **Sircar**: A possible chemical method of distinguishing between seasoned and unseasoned teak wood. The work of R. Romanis on "Certain Products from Teak" has been extended with a view to determine whether the composition of the resinous extracts might be used as a criterion for the extent of seasoning of teak wood. The results obtained by this method were not encouraging, but another is indicated wherein the percentage of a white, crystalline body obtained from the wood by steam distillation is used as an index of the amount of seasoning.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), parts 5 and 6 for 1912, contain the following memoirs communicated to the society:—

October 28, 1911.—F. **Klein** and M. **Brendel**: Materials for a scientific biography of Gauss. ii., Fragments on the theory of the arithmetico-geometric mean from the years 1797–99, explained by L. Schlesinger.

December 23, 1911.—Th. von **Kármán**: The mechanism of the resistance experienced by a body moving in a fluid.

January 13, 1912.—L. E. J. **Brouwer**: The topological difficulties in proving the continuity of the existence-theorem for one-valued reversible polymorphous functions on Riemann's surfaces.

February 18.—L. **Geiger** and B. **Gutenberg**: Seismic waves. vi., Constitution of the interior of the earth, derived from the intensity of longitudinal and transversal seismic waves, with some observations on prodromals.

March 2.—G. **Tammann**: The dependence of crystalline form upon temperature, and on re-crystallisation in conglomerates.—L. **Bieberbach**: $\Delta u = e^u$ and the automorphous functions.

BOOKS RECEIVED.

Memoirs of the Geological Survey, Scotland. The Geology of the Districts of Braemar, Ballater, and Glen Clova. By G. Barrow and E. H. C. Craig, with contributions by L. W. Hinxman. Pp. vi+138. (London: H.M. Stationery Office.) 2*s.* 6*d.*

Transport de Force. By C. Le Roy. Première Partie. Pp. ii+172. (Paris: A Hermann et Fils.) 6 francs.

The Elements of Qualitative Chemical Analysis. By Prof. J. Stieglitz. Vol. i., parts 1 and 2. Pp. xi+312. Vol. ii., parts 3 and 4. Pp. viii+151. (New York: The Century Co.) 1.40 dollars and 1.20 dollars.

Michael Heilprin and His Sons: a Biography. By G. Pollak. Pp. xvi+540. (New York: Dodd, Mead and Co.) 3.50 dollars net.

Telephotography. By C. F. Lan-Davis. Pp. xi+130. (London: G. Routledge and Sons, Ltd.) 2*s.* net.

The Sociological Value of Christianity. By Dr. G. Chatterton-Hill. Pp. xxii+285. (London: A. and C. Black.) 7*s.* 6*d.* net.

The Cotton Plant in Egypt. By W. L. Balls. Pp. xvi+202. (London: Macmillan and Co., Ltd.) 5*s.* net.

Studies in Light Production. By Dr. R. A. Houstoun. Pp. iv+115. (London: *The Electrician* Printing and Publishing Co., Ltd.) 5*s.* net.

Electromagnetic Theory. By O. Heaviside. Vol. iii. Pp. ix+519. (London: *The Electrician* Printing and Publishing Co., Ltd.) 21*s.* net.

Memoirs of the Geological Survey, England and Wales. The Water Supply of Surrey, from Underground Sources, with Records of Sinkings and Borings. By W. Whitaker, with contributions on the Rainfall by Dr. H. R. Mill. Pp. v+352+map. (London: H.M. Stationery Office.) 7*s.*

The Physics and Chemistry of Mining. By T. H. Byrom. Pp. xii+196. (London: Crosby Lockwood and Son.) 3*s.* 6*d.* net.

The Sheep and its Cousins. By R. Lydekker. Pp. xv+315. (London: G. Allen and Co., Ltd.) 10*s.* 6*d.* net.

Jahrbuch der drahtlosen Telegraphie und Telephonie. By Prof. J. Zenneck. Edited by Dr. G. Eichhorn. Band v., Heft 1–6. Pp. 650+vi. (Leipzig: J. A. Barth.)

Elementary Chemical Theory and Calculations. By Dr. J. Knox. Pp. vii+103. (London: Gurney and Jackson.) 2*s.* net.

Physiologische Morphologie. By Prof. S. Passarge. Pp. 205. (Hamburg: L. Friederichsen and Co.)

Perfect Health for Women and Children. By E. S. Chesser. Pp. xi+276. (London: Methuen and Co., Ltd.) 3*s.* 6*d.* net.

The Mechanistic Conception of Life. By Dr. J. Loeb. Pp. vi+232. (Chicago: The University of Chicago Press; Cambridge: The University Press.) 6*s.* net.

Katalog der paläarktischen Hemipteren. By B. Oshanin. Pp. xvi+187. (Berlin: R. Friedländer und Sohn.) 12 marks.

Conférences sur Quelques Thèmes Choisis de la Chimie Physique Pure et Appliquée. Faites à l'Université de Paris du 6 et 13 Mars, 1911. By S. Arrhénius. Pp. ii+113. (Paris: A. Hermann et Fils.) 3 francs.

Life: its Nature, Origin, and Maintenance. By Prof. E. A. Schäfer. Pp. 36. (London: Longmans and Co.) 1*s.* net.

The Growth of Groups in th Animal Kingdom. By Dr. R. E. Lloyd. Pp. vii+185. (London: Longmans and Co.) 5*s.* net.

The Snakes of South Africa: their Venom and the Treatment of Snake Bite. By F. W. Fitzsimons. New edition. Pp. xvi+547. (Cape Town and Pretoria: T. M. Miller; London: Longmans and Co.) 12*s.* 6*d.* net.

A Text-book of Physics. By H. E. Hurst and R. T. Lattey. 3 vols. Pp. vi+205; 177; 258. (London: Constable and Co., Ltd.) 3*s.* 6*d.* net; 3*s.* 6*d.* net; 4*s.* net.

DIARY OF SOCIETIES.

THURSDAY, October 17.

Institution of Mining and Metallurgy, at 8.—The Flotation Process: as applied to the Concentration of Copper Ore at the Kyloe Copper Mine, New South Wales: J. W. Ashcroft.—Notes on the Collection of Precious Metals as Speiss in the Smelting of Antimonial Concentrates: G. C. McMurtry.—A System of Sand-filling used on the Rand: R. E. Sawyer.

FRIDAY, October 25.

Institution of Mechanical Engineers, at 8.—Characteristic Dynamical Diagrams for the Motion of a Train during the Accelerating and Retarding Periods: Prof. W. E. Dalby.

Physical Society, at 5.

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

INDEX NUMBER.

No. 2243, Vol. 90] THURSDAY, OCTOBER 24, 1912 [Price One Shilling

Registered as a Newspaper at the General Post Office.]

THURSDAY, OCTOBER 24, 1912.

THE DAWN OF LAND VERTEBRATES.

American Permian Vertebrates. By Prof. S. W. Williston. Pp. v+145+38 plates. (Chicago, Ill.: The University of Chicago Press; Cambridge [Eng.]: University Press, n.d.) Price 10s. net.

IT is now evident that not only amphibians, but also reptiles with considerable diversity of habits and structure, arose in several parts of the world before the close of the Carboniferous period. It is thus becoming more and more difficult to interpret the relationships of the numerous genera—even those known by complete skeletons—which have already been described from the Permian rocks of Europe, North America, Brazil, and South Africa.

Some years ago, when only a few types were known, the direct passage from amphibians to reptiles, and that from these early groups to mammals, seemed to be almost discovered; but later researches have complicated rather than simplified the problem, and at present no satisfactory classification is possible. Realising this position, Prof. Williston and his colleagues are devoting themselves to a precise description of the numerous important skeletons and skeletal fragments which they have obtained from the Permian of Texas and New Mexico, and the small, well-illustrated volume now before us is one of the results. As Prof. Williston truly remarks, "the chief need in the palæontology of the early vertebrates is more facts," and students will gratefully accept the rich collection offered to them in his new work.

Photographs of restored skeletons of the theromorph reptiles Varanosaurus and Casea are given to show how astonishingly similar is their general aspect to that of the contemporaneous amphibian Eryops. Other figures and descriptions suffice to indicate that there is no longer any single skeletal character by which an early reptile can be distinguished from an early amphibian; but Prof. Williston thinks that when the sum-total of characters of a skeleton is considered, there is still no difficulty in assigning the specimen to its true place in one or other of the two classes.

In some groups the various modifications of the skull seem likely to prove as numerous as those observable among modern lizards, so that caution is necessary in dealing with fragments. These and other difficulties, however, can only be recognised and overcome through the progress of such technical and detailed descriptive work as that which we welcome from the professor of palæontology in the University of Chicago.

A. S. W.

SCIENCE OF THE SOIL.

Soil Conditions and Plant Growth. By Dr. Edward J. Russell. Pp. viii+168; with diagrams. (London: Longmans, Green and Co., 1912.) Price 5s. net.

"HOW the chemist can help the farmer. He can analyse the soil and the crop, and by comparing the results of his analyses, can tell the farmer how to manure his land so as to grow profitable crops." The above is a quotation, as nearly as the writer can remember, which formed the preface to a syllabus on which he was asked to give a course of local lectures about twenty years ago, when local lectures were in full swing under the newly-constituted technical education committees of the county councils.

At that time there was some excuse for such misconceptions, for the literature of the somewhat hybrid subject known as agricultural chemistry was scattered through numerous periodicals, mostly in foreign languages, and by no means easily accessible to the budding lecturer. Since then many excellent text-books have been written, and are now in the hands of both teachers and students. None of them, however, go to the root of the matter, and give the substance of the classical researches which should form the foundations of the faith of the agricultural chemist, as does Dr. Russell's excellent monograph.

Dr. Russell has made a comprehensive survey of the literature of the subject so far as it deals with the relations between the soil and the plant. He has succeeded in giving the gist of the more important and fundamental contributions to the knowledge of the subject, and in pointing out with true critical spirit what is really proved to demonstration and in what directions further investigation is necessary.

His book will be of the greatest use both to the teacher of agricultural chemistry and to the investigator—to the latter especially, as it will put him in touch with the literature of the subject. It can scarcely fail to stimulate in this country the output of definite experimental work on the various problems connected with plant-growth. The chapter on soil analysis and its interpretation will be particularly welcome to the staffs of the several colleges who are engaged on soil surveys of their own districts, or are contemplating such surveys. It should do much towards guiding their work on to really useful lines.

The book is printed and issued in the same style as the other well-known "Monographs on Biochemistry." It is singularly free from errors of all kinds, but there is a slip on p. 91, where the formula of potassium phosphate is written K_2PO_4.

T. B. W.

PHILOSOPHY AND PSYCHOLOGY.

(1) *Outdoor Philosophy: The Meditations of a Naturalist.* By Stanton Davis Kirkham. Pp. xii+214. (New York and London: G. P. Putnam's Sons, 1912.) Price 5s. net.

(2) *An Introduction to Psychology.* By Prof. Wilhelm Wundt. Translated from the second German edition by Dr. Rudolf Pintner. Pp. xi+198. (London: George Allen and Co., Ltd., 1912.) Price 3s. 6d.

(3) *The Composition of Matter and the Evolution of Mind. Immortality a Scientific Certainty.* By Duncan Taylor. Pp. 176. (London and Felling-on-Tyne: The Walter Scott Publishing Co., Ltd., 1912.) Price 3s. 6d.

(4) *The Triuneverse: A Scientific Romance.* By the author of "Space and Spirit." Pp. xiv+221. (London: Charles Knight and Co., Ltd., 1962!) Price 5s. net.

(1) THIS book is a pleasure and a refreshment to read. It is not exactly science, or philosophy, or religion, but it partakes of all three, and each is at its best in Mr. Kirkham's pages. Further, the literary quality, apart from the matter, is excellent. It is not too much to say that the reader is continually reminded of Emerson and Thoreau, by whom, indeed, the author has been influenced and inspired; yet there is no plagiarism—we feel the originality of his nature-impressions. "Something in me, deaf to all preaching, responds to that bluebird's note." "And there is the sky—the unimproved sky—the only dome that gives room for thought, the only roof that does not sometimes seem too near." Our life is sick and artificial: the birds and beasts and trees are sounder and saner than we, though they know nothing of soundness and sanity. With our book-learning and our words, words, words, we confuse ourselves until we forget to learn from Nature at first hand. Let us go to the woods and listen, the sweet wind washing us clean of morbid artificialities, and refreshing us after our contact with a "too garrulous and gregarious world."

An admirable book. May it be widely read!

(2) This is a popular introduction to the Wundtian psychology. It is translated from the second edition of the work which has had such a remarkable success in Germany. The author begins with metronome-experiments, showing the scope of consciousness and its "rhythmical" nature, with the difference between apprehension and apperception. He then proceeds to differentiate sensation and idea (simple and complex awarenesses), giving his own and rather unusual meaning to the latter word, which with most writers means a complex that does not arise from direct outward impressions. There is much to be said in favour of the Wundtian use. From this we go on to association and feeling, and the growth of abstract concepts from concrete ones perceptions. The last chapter deals with the "laws of psychic life," holding close to psychophysical parallelism (which truly needs emphasising, in view of Bergson's ably urged heresies in "Matière et Mémoire"), and admonishing metaphysics to base itself on facts and to beware of abstractions.

Prof. Wundt and his translators are to be thanked. In this volume they give us the best elementary book of its size and kind that exists in English.

(3) The sub-title will probably have an effect contrary to the expectations of the author. Thoughtful readers—still more men of scientific training—are rendered at once suspicious by "certainties," and are apt to avoid books which make great claims. And, indeed, in this case they would be justified. The book is a queer collection of incoherent paragraphs, and, so far as the present reviewer can see, does not prove anything. Such paragraphs as are comprehensible often contain the most reckless statements, as, *e.g.*, "we know that the solar system itself, with its full-orbed, glorious centre, is circling round a greater centre" (pp. 12, 13). Similarly, the planetary structure of the atom is too stiffly put. These things may be true, but at present they are not more than provisional hypotheses or even (as in the astronomical sentence) wild guesses. We sympathise with the author's aims and feelings in certain points, but he should have made his book more carefully accurate and more coherent. He jumps about too much from physics to metaphysics—Christ and gravitation, God and æther, omniscence and mass. If we may be permitted the phrase, we might say that he seems to have got intoxicated on M. le Bon.

(4) One gets rather tired of these "Looking Backward" books, which usually follow Mr. H. G. Wells, *longo intervallo.* The one under review begins at 1950 A.D., and opens with a description

of some astronomers watching Mars split into two, then into four, and finally into about 500 bits. This cluster then proceeds to swallow Jupiter and Saturn; the sun blows up, and the earth starts off somewhere on a wild career, with a piece of sun just big enough to keep it fairly warm. Then two of our astronomers suffer a magical shrinkage in size, entering the infratonic (less than electronic) world. And here we may as well leave them, for NATURE is a scientific journal, and this book, though a romance of science, is more of the former than the latter.

J. A. H.

NEW BOOKS ON CHEMISTRY.

(1) *Per-acids and their Salts.* By Dr. T. Slater Price. Pp. vi+123. (London: Longmans, Green and Co., 1912.) Price 3*s.* net.

(2) *Researches on Cellulose.* III. (1905–1910). By Cross and Bevan (C. F. Cross and E. J. Bevan). Pp. x+173. (London: Longmans, Green and Co., 1912.) Price 7*s.* 6*d.* net.

(3) *Modern Research in Organic Chemistry.* By F. G. Pope. Pp. xii+324. (London: Methuen and Co., Ltd., n.d.) Price 7*s.* 6*d.*

(4) *A Second Year Course of Organic Chemistry for Technical Institutes.* The Carbocyclic Compounds. By F. B. Thole. Pp. vii+186. (London: Methuen and Co., Ltd., n.d.) Price 2*s.* 6*d.*

(5) *Experimental Science.* II., Chemistry. By S. E. Brown. Pp. vii+140. (Cambridge University Press, 1912.) Price 2*s.*

(6) *First Year's Course of Chemistry.* By James Sinclair and George W. M'Allister. Pp. vii+165. (London: G. Bell and Sons, Ltd., 1912.) Price 1*s.* 6*d.*

(7) *Elementary Quantitative Analysis.* By Dr. William Briggs and H. W. Bausor. Pp. viii+122. (London: W. B. Clive, University Tutorial Press, Ltd., 1912.) Price 2*s.*

(8) *Chemical Theory and Calculations.* An Elementary Text-book. By Dr. F. J. Wilson and Dr. I. M. Heilbron. Pp. iv+138 (London: Constable and Co., Ltd., 1912.) Price 2*s.* 6*d.* net.

(1) DR. PRICE'S monograph on the per-acids and their salts is the second volume of a series of monographs on inorganic and physical chemistry, the previous volume (Mr. Soddy's book on the chemistry of the radio-elements) having been reviewed recently in these columns. One half of the book is occupied with an account of the persulphuric acids and persulphates, the remainder of the volume dealing with perborates, percarbonates, pernitric and perphosphoric acids; pertitanates, perzirconates and perstannates; pervanadates, percolumbates, and pertantalates; perchromates; permolybdates, pertungstates and peruranates. The new volume will go far to establish the reputation of the series for thoroughness and utility. More than three hundred references are given to the literature of a subject which would scarcely have been credited by the ordinary readers with having provided material for one-half this number of papers.

A word of comment may be added in reference to the author's criticism of the view that in presence of concentrated sulphuric acid, the peroxidised material consists mainly of pertetrasulphuric acid, $H_2S_4O_{14}$. Such solutions on dilution undoubtedly yield an oxidised acid of the formula H_2SO_5. But the appearance of this acid is quite compatible with its formation by hydrolysis on the dilution of a solution containing the higher acid, as shown by the equation

$$H_2S_4O_{14}+3H_2O=3H_2SO_4+H_2SO_6;$$

such a hydrolysis would not disturb the ratios of "persulphuric oxygen" to "peroxide oxygen," on which the formula $H_2S_4O_{14}$ was based. The hydrolysis of Marshall's acid to Caro's acid, as shown by the equation

$$H_2S_2O_8+H_2O=H_2SO_5+H_2SO_4,$$

by dissolving it in concentrated sulphuric acid and then diluting, presents some analogy to the conversion of ethylene into alcohol by a similar process; in each case the initial process may very well be a condensation of the hydrolyte with the acid to form a more complex substance, which is then easily hydrolysed on dilution.

(2) The third volume of Messrs. Cross and Bevan's "Researches on Cellulose" covers the five years from 1905 to 1910, but has been delayed to include research work published in 1911. Special interest attaches to the final chapter on technical developments, in which a brief account is given of some important modern cellulose industries. It is noted that in the artificial silk industry the last five years have been marked by rapid developments, accompanied by a rapid gravitation to the level of competitive prices. This has arrested the development of the collodion processes, and has accentuated the struggle between the cuprammonium and viscose processes, in reference both to relative costs and to the textile qualities of the products. A remarkable development consists in the production of transparent films of viscose in lengths of 1000 to 10,000 metres at an average width of a metre, and at a thickness of 0·25 down to 0·01 mm. In view of the fact that the process involves (1) coagulation, (2) purification from sulphur, (3) bleaching and purification by special washings,

and (4) drying, and, moreover, that the shrinkage in width may amount to 30 to 40 per cent., this accomplishment is little short of marvellous. It is accomplished by a single machine, but this has a length of 50 to 60 metres. The material can be coloured and embossed in a very effective way, as is shown by a series of seven samples enclosed with the volume. Experiments are also described on cellulose acetate, which serves, amongst other purposes, as an excellent material for insulating the wire of galvanometers and other instruments in which its extreme thinness gives it a marked advantage.

(3) Mr. Pope's book on modern research in organic chemistry is one of those useful summaries of research work that have formed a conspicuous feature of recent publications. The subjects selected are the polymethylenes, terpenes and camphors, the uric acid group, the alkaloids, colour and constitution, salt-formation, pseudo-acids and bases, the pyrones, ketenes, ozonides and triphenylmethyl and the Grignard reaction. The work has been well and thoroughly done, and full bibliographies are given. The book will therefore be of considerable service both to honours students and to teachers who are not able to acquire complete series of the journals in which original papers are published, but will be glad to place this book upon their shelves.

(4) The "Second Year Course of Organic Chemistry" deals with the carbocyclic compounds, and does not differ very widely in its treatment from other books of a similar type. Some of its most valuable features are found in the appendices, which contain a scheme for qualitative organic analysis and tables of physical constants, suitable for use in identifying organic compounds.

(5) This little book covers a course of elementary chemistry which should be completed in two years by a class working two hours a week. It is based upon the report presented at the Newcastle-upon-Tyne meeting of the British Association by the committee formed to investigate the methods of teaching chemistry. The author claims to have been one of the first to put the suggestions of that committee to a complete practical test in the laboratory. He has found it advantageous to short-circuit the heuristic method in its strictly historical form, and thus finds a proof of the presence of oxygen in lime by direct combustion of metallic calcium. In one respect he has broken away from a hoary tradition, and in reconstructing Lavoisier's decomposition of the oxide of mercury has provided a spirit-lamp as a source of heat in place of the Bunsen burner usually introduced into the picture. It is unfortunate that he should have introduced the terms monoxide and dioxide before the significance of these terms can be explained; as a matter of historical treatment the anachronism may be pardoned in a book that does not profess to teach history, but there would be a great logical advantage in using in place of "carbon dioxide" one of the earlier names, "fixed air," "carbonic acid gas," or "carbonic anhydride."

(6) The "First Year's Course of Chemistry" is arranged in such a way that the experimental work of each lesson occupies the earlier part of each chapter, and is followed by a discussion of the results of the experiments. This system, which has been adopted in at least one other class-book of chemistry, possesses obvious advantages in actual practice, as it agrees with the system followed in the laboratory. The course is intended to occupy a single session, with an allowance of three or four hours per week on the time-table, and covers much the same ground as the volume noted in the preceding paragraph, the direct combustion of calcium being used here also to prove the nature of lime.

(7) The Tutorial "Elementary Quantitative Analysis" describes the simplest forms of gravimetric and volumetric analysis. A conspicuous feature of the book is the introduction of a large number of problems as variants on the usual direct analyses. These resemble closely the problems set in recent examinations, and will doubtless serve to brace the student to face the ordeal of a practical test in quantitative analysis.

(8) The text-book on chemical theory and calculations is primarily intended to provide a series of numerical examples of the different types of calculations that are likely to occur in a course of chemistry. The text is confined almost entirely to stating the theories and describing the apparatus involved in the problems, but some half-dozen chapters have been included which deal with subjects, such as the periodic classification of the elements, which do not lend themselves to numerical exercises. T. M. L.

OUR BOOKSHELF.

Handbook of the Technique of the Teat and Capillary Glass Tube, and its Applications in Medicine and Bacteriology. By Sir A. E. Wright, F.R.S. Pp. xvi+202. (London: Constable and Co., Ltd., 1912.) Price 10s. 6d. net.

In this book Sir Almroth Wright gives a full account of the ingenious apparatus and methods which he and his co-workers have evolved for making quantitative estimations, principally in connection with the blood and other body fluids. It is generally not possible in this kind of work to deal with quantities greater than a small fraction of a cubic centimetre, and therefore ordinary graduated pipettes and measures are not applicable. It is true that graduated pipettes to deal with such small quantities are obtainable, but they are costly, and it would be out of the question to employ them in the numbers and in the manner required, for instance, for opsonic determinations. As the author says, "it is a technique for conducting quantitative tests in uncalibrated capillary tubes with minimal quantities of reagents."

Briefly, the method consists in the use of glass pipettes, formed by drawing out a piece of glass tubing in the blow-pipe flame into a fine stem. By adapting a suction apparatus in the form of a rubber teat to the undrawn-out portion, and making a mark somewhere on the drawn-out stem, we have the means of taking up any number of minute similar volumes of a fluid and of making any mixtures of fluids and dilutions thereof required with considerable accuracy.

By an adaptation of these principles, Sir A. Wright has devised methods for estimating the bactericidal, agglutinative, and opsonic powers of the blood, for measuring the coagulation time of the blood, and for estimating quantitatively its alkalinity, content of magnesium and calcium salts, and anti-tryptic power. The making of blood-films and preparation and standardisation of therapeutic vaccines are also dealt with.

Full details are given for the manipulation of the glass in the blow-pipe, the making of the apparatus required, and the carrying out of the various procedures. The descriptions are supplemented by a profusion of illustrations in the text and five plates, four of which are coloured. Truly no bacteriological or pathological laboratory can afford to omit this book from its working library, and we fancy that the chemist and physicist might gather some hints of value from it.

R. T. Hewlett.

Lines in the Arc Spectra of Elements. By F. Stanley. Pp. 140. (London: Adam Hilger, Ltd.) Price: cloth, 12*s.* 6*d.*; half-morocco, 15*s.* 6*d.*

In this publication the wave-lengths of the chief lines in the arc spectra of fifty-five elements are given. These are arranged in one long table in the order of the wave-length numbers. The intensities of the lines in the spectrum of the undiluted element are also given on a scale of 1 to 10, the latter denoting the brightest lines. In a separate column and on the same horizon as any particular line will be found the wave-length of the next prominent line belonging to the corresponding element. This is very useful in determining whether any element is present in a substance under investigation. The most persistent lines of any given element—that is, the lines which last longest as the proportion of the element in question is gradually decreased—are specially denoted. The wave-lengths, which extend from λ 7900 to λ 2200, are given to the nearest tenth of an Angström unit, and have been taken from the most recent and trustworthy measures available. The pages opposite the wave-length tables are left blank for the insertion of notes. To practical workers in elementary spectroscopic analysis the compilation will be decidedly useful.

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.*]

X-rays and Crystals.

Messrs. Friedrich, Knipping and Laue have recently published (*K. Bayer. Akad. der Wiss.*, 1912, p. 303) some remarkable effects obtained by passing a fine stream of X-rays through a crystal before incidence upon a photographic plate. A curious arrangement of spots is found upon the plate, some of them so far removed from the central spot that they must be ascribed to rays which make large angles with the original pencil.

The positions of these spots seem to depend on simple numerical relations, and on the mode in which the crystal presents itself to the incident stream. I find that when the crystal (zincblende) is placed so that the incident rays are parallel to an edge of the cube in the crystal the positions of the spots are to be found by the following simple rule. The atoms being assumed to be arranged in rectangular fashion, any direction which joins an atom to a neighbour at a distance na from it, where a is the distance from the atom to the nearest neighbours and n is a whole number, is a direction which a deflected (or secondary) pencil will take, and it will in doing so form one of the spots. In other words, we have to seek for all the cases in which the sum of three squares is also a square, and we then recover the positions of all the spots on the diagram. For example, secondary pencils take the directions (2, 3, 6) (4, 1, 8), and so on. In a few cases the sum of the squares is one short of a perfect square, *e.g.* (5, 7, 11), but in no case is it on the greater side; and there is at least one direction (2, 5, 14) which ought by the rule to be on the diagram and is not. Otherwise the rule is quite successful.

Until further experimental results are available, it is difficult to distinguish between various explanations which suggest themselves. It is clear, however, that the diagram is an illustration of the arrangement of the atoms in the crystal.

The rule has suggested itself to me as a consequence of an attempt to combine Dr. Laue's theory with a fact which my son pointed out to me, viz. that all the directions of the secondary pencils in this position of the crystal are "avenues" between the crystal atoms.

W. H. Bragg.

Leeds, October 18.

Glaciation and Striation.

In your issue of September 26, Dr. A. Irving asks whether in my plate 17 (Phil. Trans., Ser. B., vol. ccii) I have not overlooked the fact that the striations are on the original cortex of the flint nodule. My answer is that I have not done so; the striations are *not* on the original cortex of the flint nodule—as is clear both from my description of the specimen and from the carefully drawn figure.

Dr. Irving also asks whether I have overlooked the probability that the markings shown in Fig. 2 are the etched-out skeletons of some spongoid fossil. My reply is that no such probability exists, and that, in consequence, I have not overlooked it.

Your correspondent appears to be under some misapprehension. He has never seen the specimen referred to. Moreover, he is mistaken in supposing that I am not acquainted with the facts and theories as to the structure and history of flint in its various conditions. As a matter of fact, this subject has occupied my attention during the greater part of a lifetime.

The specimens of "worked" flints from the sub-Crag detritus-bed—dealt with in my recent paper in the Phil. Trans.—have now been presented to the Department of Ethnology of the British Museum (Bloomsbury), and it is now possible, for those who wish to do so, to study the actual material upon which my statements are based, and to discuss them with the needful preliminary knowledge of the things under discussion. E. RAY LANKESTER.

29 Thurloe Place, South Kensington.

Nautilus Pearls.

THE letter from Mr. H. Lyster Jameson in the last number of NATURE reminds me that I have in my possession a small pearl that is alleged to have been found in a Nautilus. It was given to me by a Dutch magistrate in North Celebes, who had in turn received it from a native. It is irregularly pear-shaped, and weighs 2·75 grains.

As there is so little substantial evidence that this or any other pearl or stone has really been formed within the body of a pearly Nautilus, I have never felt disposed to assert that I possess a Nautilus pearl. However, there can be no doubt whatever that there is a widespread belief among the natives of the Malay Archipelago and Polynesia that such pearls are occasionally found, and although in the Sulu Archipelago, according to Mr. Haynes's account, they are regarded as unlucky, in Celebes they are treasured as charm stones that bring good fortune.

Rumphius, in his "D'Amboinsche Rariteitskamer," published in 1702, gives a description of such a stone found in a Nautilus, and relates an interesting story connected with it. He says that the stone belonged to a Chinese woman in Boero, who had kept it in a little box and treasured it as a charm. One day she discovered that it had given birth to another small pearl, and later on two other small pearls were born in a similar manner. This statement reminded him of the story told by Pliny in Lib. 37 of the reproductive stones called Peantides and Gemonides.

SYDNEY J. HICKSON.

The University, Manchester, October 18.

Sailing Flight of Birds.

THERE can scarcely be a doubt that Prof. E. H. Hall has given, in NATURE of October 10, the true explanation of the sailing flight of gulls when they follow a ship without any movement of their wings. When there is a fairly strong head-wind or a wind which, without being strictly a head-wind, makes a small angle with the line of the ship's course, the gull has an up-current of air provided for him which will not only support him, but which, if he inclines his body (and supporting surfaces generally) slightly downward, will enable him to make headway.

Sometimes the gull will hang directly over the stern, at others slightly to windward, at others, but I think not so often, slightly to leeward. Some experiments which I once made with a vane that worked vertically showed that when the wind strikes a bank six feet high at right angles, there is a steady up-current four yards to windward. Five yards to leeward there was a down draught, and some ten yards to leeward irregular up-and-down draughts. Recently in Texel I frequently saw gulls hovering with motionless wings a few yards to windward of embankments some twenty feet high. F. W. HEADLEY.

Haileybury (Hertford), October 13.

The Zodiacal Light.

As of possible interest to some of your readers I beg to report to you a phenomenon which I have observed here during the last ten days. It may be described as follows: every evening after sunset when twilight has completely died out of the western sky there is observable an illumination, starting due west and extending upwards to a height of about 40° above the horizon, fading away towards the top; in character it is much like the Milky Way, a little broader at its base, slightly less brilliant but more uniform. It extended this evening (August 10) from a point due west at 7.30 p.m., Gallegos mean solar time, upwards to a height of about 35° from the horizon, in the direction of the planet Jupiter, inclining towards the north at an angle with the horizon of about 60°. A curious fact I noticed in connection with this phenomenon was that it was best observed when the rays from it were allowed to fall on the periphery of the retina, as when the eyes were fixed on a point about 20° distant. It could be observed for about two and a half hours after sunset, gradually setting in the west. I presume this is the zodiacal light, but as I never noticed the same phenomenon in these latitudes (51° south) before, I thought it worth while mentioning the fact. E. G. FENTON.

Rio Gallegos, Patagonia, Argentine Republic, August 10.

Colours of Plasmodia of Some Mycetozoa.

To my communication under this heading that appeared in NATURE of June 23, 1910, p. 489, allow me to make the following additions:—

Species of Mycetozoa.	Colours of Plasmodia.
Physarum variabile, Rex, var. *sessile*, Lister	Orange yellow.
Colloderma oculatum, G. Lister	Dingy watery-white with greenish or olivaceous tinge, then ochraceous, ultimately ferruginous and dirty throughout.
Cribraria intricata, Schrad.	Pitch-black when the plasmodium is thick, and oil-brown when it is thin; in either shade it closely simulates the solution of asphalt in oil of turpentine.
Perichaena chrysosperma, Lister.	Stated to be pale brown in Lister's "Monograph," second edition, 1911, p. 248, but I found it to be pallid pink.
Craterium concinnum, Rex.	Said to be yolk-coloured in the same work, p. 95, but I found it milky, then cream-coloured.

Since my letter above mentioned was published, I have gathered nineteen species new to Japan, which make the native Mycetozoa taken altogether amount to 105 species, of which three are new to science, viz. *Arcyria glauca*, Lister, *Hemitrichia minor*, G. Lister, and *Diachaea robusta*, G. Lister.

KUMAGUSU MINAKATA.

Tanabe, Kii, Japan, September 17.

THE "MICHAEL SARS" IN THE ATLANTIC.[1]

THE cruise of the *Michael Sars* in the North Atlantic in 1910 has shown what a great deal of excellent work in investigating the deep waters of the ocean can be done by a comparatively small vessel, when the best possible equipment is provided, and men of exceptional competence and experience are in charge. Sir John Murray's judgment was sound when, instead of fitting out *de novo* a larger vessel for the investigations he wished to carry out in the Atlantic, he arranged with the Norwegian Government for the use of its fishery research steamer, a vessel only 125 feet long and of 226 gross tonnage, together with her scientific staff and crew. The immense advantage of proved men, accustomed to work together, and each thoroughly competent in his own particular line, for the successful execution of investigations of the very difficult kind which were undertaken by this expedition cannot be overestimated.

The work of the expedition was not only well done, but the results are being well presented both to the scientific and to the lay public. The detailed scientific reports are to be published in a series of volumes issued by the Bergen Museum, and will without doubt constitute a valuable and permanent addition to our knowledge of the physical and biological conditions of the Atlantic. The book now under review is designed to appeal to a wider public, and from the interesting way in which the facts are presented and the large number of excellent illustrations which it contains, it can scarcely fail to achieve its purpose. Although the book is chiefly devoted to an account of one particular expedition, Sir John Murray and Dr. Hjort have taken the opportunity, as the sub-title indicates, of placing before the public "a general account of the modern science of oceanography." The success with which the authors, and those who have collaborated with them, have carried out their task makes "The Depths of the Ocean" by far the best English book from which the general reader can gain a trustworthy knowledge of the aims and progress of the modern science of the sea.

Within the limits of a single article it would be quite impossible to give any adequate account of the wealth of interesting matter which this large volume contains. It will only be possible, therefore, whilst noting the general contents of the several chapters, to direct special attention to some of the questions upon which the results of the *Michael Sars* expedition have thrown new light.

The first chapter, on the history of oceanographical research, is written by Sir John Murray. It condenses and brings up to date the well-known historical account of the subject which Sir John wrote for the "Summary" volume of the *Challenger* reports. If a word of criticism may be allowed, it seems a pity that the more recent work around the coasts of north Europe, more particularly that done in connection with the international investigations, receives such slight reference. We should have been glad to see some more detailed notice of the brilliant achievements of the Danish workers in the North Atlantic, and one would have expected a good Scotsman like Sir John Murray to have at least mentioned the important work done by the Scottish Fishery Board, even though he did not consider that carried out by England and by Ireland as worthy of a place.

FIG. 1.—S.S. *Michael Sars* in Plymouth Harbour. From "The Depths of the Ocean."

In the second and third chapters Dr. Hjort gives a narrative of the cruise, with many details of the equipment of the ship and the methods of work. The feature of most interest to the working naturalist is perhaps the account of the number of different pieces of apparatus for capturing pelagic animals which it was found possible to work at one and the same time. As many as nine or ten nets, including two or three Petersen young-fish trawls and some very large tow-nets, were towed together at different depths, and appear to have worked well.

[1] "The Depths of the Ocean." A General Account of the Modern Science of Oceanography based largely on the Scientific Researches of the Norwegian Steamer *Michael Sars* in the North Atlantic. By Sir John Murray, K.C.B., F.R.S., and Dr. Johan Hjort. Pp. xx+821. (London: Macmillan and Co., Ltd., 1912.) Price 28s net.

Sir John Murray's principal contribution, which is on the depths and deposits of the ocean, constitutes chapter iv. The chapter is mainly devoted to a general account of these subjects. Written as it is by the greatest living authority, in a style as interesting as it is scientifically accurate, it cannot fail to be welcome to all who wish to learn the present position of our knowledge of the configuration of the ocean basins and the nature of the deposits which lie upon their floors. The section dealing with the mineral collections obtained during the cruise of the *Michel Sars* is by Drs. Peach and Horne, who examined the specimens. The most interesting fact recorded by them is the discovery of glaciated stones, some of which are illustrated, at a depth of a little more than a mile, at a point 230 miles south-west of Mizen Head, Ireland.

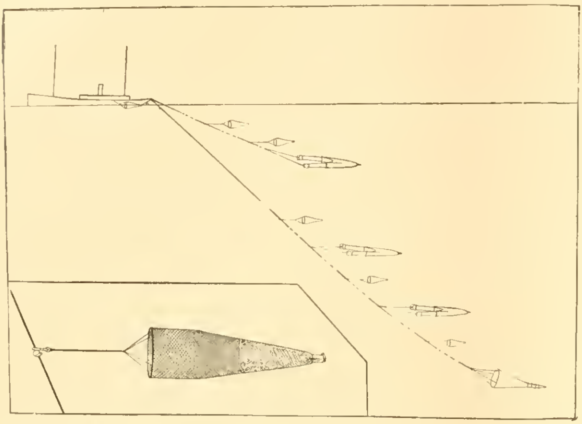

Fig. 2.—The *Michael Sars* towing ten nets and pelagic trawls (surface net not shown). From "The Depths of the Ocean."

Dr. Helland-Hansen's chapter on physical oceanography is certainly the best summary of the modern aspects of this subject which has yet appeared in English. Of the work of the expedition itself the striking features are the direct measurements of the currents entering and leaving the Mediterranean through the Straits of Gibraltar, the determination of the depths to which an amount of light penetrated sufficient to produce an effect on photographic plates, and the very close agreement which was found in the deep-water temperatures taken by the best modern instruments with those taken at the same stations by the *Challenger* expedition more than thirty years before.

Dr. Helland-Hansen is followed by Prof. Gran, with an account of the pelagic plant life, one of the most interesting chapters of the whole book. The general subject is treated in a masterly way, and the importance of these minute vegetable organisms, forming as they do the fundamental food supply of the ocean, cannot be overrated. The special contribution of the expedition to the advancement of this subject is the discovery, by means of a large centrifuge worked by the steam-winch of the vessel, of the extraordinary abundance of the most minute plankton forms, especially in the warmer seas. These forms are so small that they pass through the meshes of the finest silk nets, yet they occur in such vast quantities that they constitute in these waters perhaps the most important part of the pelagic plant life.

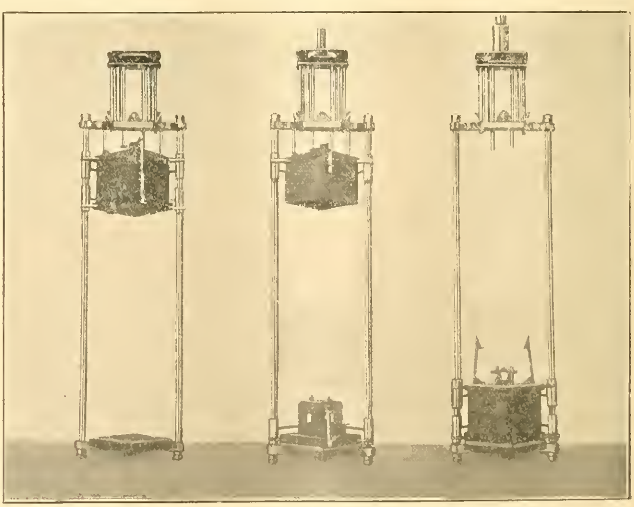

Fig. 3. Helland-Hansen's photometer. On the left, as it is sent down; in the middle, open for exposure; on the right, closed and ready for hauling up. From "The Depths of the Ocean."

Sections dealing with the bottom fauna are contributed by Dr. Hjort and Dr. Appellöf in chapters vii. and viii., the former writing on the fishes, the latter on the invertebrates. It is a task of no little difficulty to treat such extensive subjects in a concise and yet comprehensive way. With the help of a large series of figures illustrating the numerous species mentioned, both authors have succeeded well, and it is to be hoped that their efforts may result in reviving popular as well as general scientific interest in these branches of marine biology, which, fascinating as they are, have rather tended to become of late years entirely relegated to specialists on particular groups.

Following these, chapter ix., on pelagic animal life, by Dr. Hjort, contains perhaps the largest proportion of original matter to be found in the book. This is due to the fact that the collecting gear chiefly used by the expedition consisted of townets and large pelagic nets of various patterns, all of them of very much greater fishing capacity than the nets which have previously been used in ocean work. From the nature of the results already reached—and the material has as yet been only partially worked out—it seems clear, as Dr. Hjort maintains, that the qualitative results obtained by the use of these large nets towed for long periods give a more correct and comprehensive picture of the free-swimming life of the Atlantic than was obtained with the relatively small nets used by the German plankton expedition, the material from which Prof. Hensen and his helpers have attempted to work out quantitatively at the cost of such vast labour.

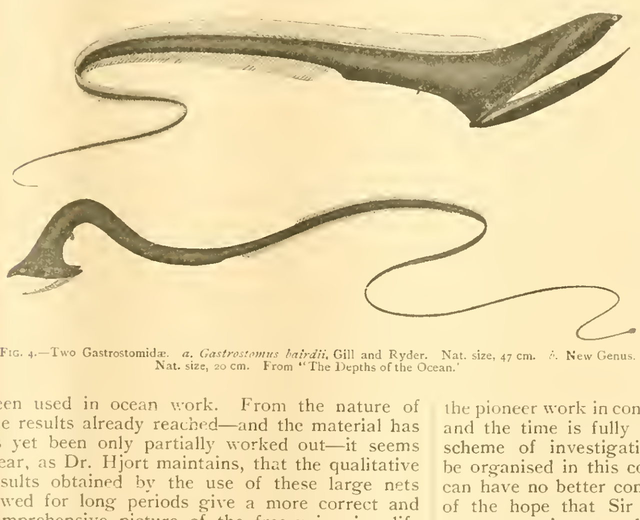

FIG. 4.—Two Gastrostomidæ. *a. Gastrostomus bairdii*, Gill and Ryder. Nat. size, 47 cm. *b*. New Genus. Nat. size, 20 cm. From "The Depths of the Ocean."

The final chapter, entitled "General Biology," is also written by Dr. Hjort. It deals with innumerable problems of scientific importance in a most suggestive and stimulating way, and maintains the high standard of the whole book to the end. Among the numerous questions dealt with are the colours of marine animals and their relation to the conditions in which these animals live, phosphorescence and luminous organs, the eyes of deep-sea fishes and the meaning of the great variations in their size in different species, the factors which influence the floating of pelagic organisms, and the organs which are special adaptations for floating.

One other subject in this final chapter must not be passed without notice—namely, the valuable contribution made by the *Michael Sars* expedition to the wonderful story of the life-history of the fresh-water eel. The expedition secured numerous eel larvæ of stages much younger than any previously found, and from the distribution of these larvæ the conclusion seems justified that the eel spawns south of the latitude of the Azores, and the larvæ are later carried into the northern North Atlantic and towards the coasts of northern Europe by the Gulf Stream.

Nothing could be more calculated than this book to awaken fresh interest in the importance of the thorough and complete investigation of the problems of the great oceans. A knowledge of the changes which take place from season to season and from year to year in the Atlantic would be of incalculable value to every country in Europe, for there can now be scarcely a doubt that it is upon these changes that the variations in the yield of the harvests both of the land and of the sea are mainly dependent. These changes can never be ascertained by single cruises such as that of the *Michael Sars*, brilliantly though that cruise was carried out. What we now want is systematic and sustained researches extending over a period of years. Great Britain did the pioneer work in connection with ocean research, and the time is fully ripe when a comprehensive scheme of investigation in the Atlantic should be organised in this country. The present notice can have no better conclusion than the expression of the hope that Sir John Murray will use his great experience and commanding position in trying to ensure that the British Government should make the necessary provision for such an investigation.

E. J. ALLEN.

THE SWISS SOCIETY OF NATURAL SCIENCES.

THE Société Helvétique des Sciences naturelles, which, in Switzerland, takes the place of a scientific academy, and is the centre of all concerted action in the scientific life of that country, held its annual reunion at Altdorf, in the canton of Uri, on September 8–10.

The first day was devoted to a general assembly, at which various matters were discussed, and some general addresses also delivered. Profs. Kovalski, Wiechert, and Weiss reviewed recent work on radiations, atmospheric electricity, and the *rôle* of magnetic phenomena in the study of molecular and atomic conceptions. The second day was devoted to meetings of sections, at which a great number of communications were presented on mathematics, physics, chemistry, geology and mineralogy, botany, and zoology. Finally, on the concluding day another general assembly was held, again devoted to administrative matters and general addresses, among which may be specially mentioned that by Prof. Chodat, on vegetable pigment, and that by Dr. Paul Sarasin, on the Swiss National Park.

The Société Helvétique des Sciences naturelles, founded at Geneva in 1815, has been the moving spirit in many important scientific undertakings in Switzerland. It has successfully created, or, at least, been the means of creating, the fine topographical map of Switzerland, the geological, geodetical, and meteorological services, the investigations of earthquakes, glaciers, rivers, lakes and marshes. The various branches of work are directed by special commissions or committees, selected from the Society's ranks, which send in reports annually; they receive grants from the Swiss Government totalling annually about 80,000 francs (3200*l*). As each branch expands in course of time, and grows in importance, it is usually taken over by the Swiss Government and given an independent organisation. It is in this way that the Swiss Federal Services of Topography and Meteorology have originated, and the seismological service started and organised by the Society is now passing into the hands of the Federal Government in like fashion. By way of counterpoise, the creation of a new commission was decided at the Altdorf meeting, to be charged with organising studies and regular observations of atmospheric electricity.

But of all the recent activities of the Society, the most interesting for its importance and bearing is the work of the Commission for the Protection of Natural Sites, organised in 1906, which has culminated in the creation of a magnificent national park, situated in the lower valley of the Inn (Grisons), one of the wildest parts of the Swiss Alps. In accordance with contracts made with the commune of Zernez and various neighbouring communes, an uninterrupted stretch of territory of about 100 square kilometres area, which it is hoped soon to extend to 200 square kilometres, will be almost completely withdrawn from the interference of man. The flora and fauna, which are here relatively very rich—the region is still frequented by chamois, and a few bears are still met with—will be able to develop freely in accordance with natural laws of evolution. The only exception will be a few roads or paths to give access to the reservation, and some blockhouses constructed for the purposes of repressing poaching, enforcing the prohibition of hunting, and organising a service of regular observations. It will thus be possible to study the formation of a natural "biocénose" on a somewhat magnificent scale—a true "biological refuge" of a most interesting kind.

Part of the territory leased by the Society for the National Park of the Grisons has been taken for twenty-five years, the rest for ninety-nine years. The costs of rent, surveillance, and observations will be defrayed out of funds furnished by a popular league, the "Ligue suisse pour la protection de la nature" (founded under the auspices of the Société Helvétique des Sciences naturelles), the ordinary members of which pay an annual contribution of at least a franc, and the life members a lump sum of at least twenty francs. The Federal Government also has announced its intention of applying to the Chambers for regular annual grants.

The above details, taken from the bulky report of the Central Committee, and from the interesting address of Dr. Paul Sarasin, President of the Commission for the Protection of Natural Sites, prove that Swiss naturalists have made a great achievement. The "Territoire Réservé" of the Grisons is not only the most important in Europe, on account of its extent, but in some respects excels the celebrated American Reservations, which are only partially reserved, and do not form one unbroken block.

THE UNIVERSITY OF BRISTOL.

INSTALLATION OF LORD HALDANE AS CHANCELLOR.

THE installation of Lord Haldane as Chancellor of the University of Bristol on Thursday last, October 17, in succession to the late Mr. H. O. Wills, was made the occasion of a brilliant and memorable ceremony. Bristol, the ancient city of the west, is the youngest of the new universities; and it is peculiarly fortunate in having secured for its chancellor one who represents the modern spirit of organisation and progress. In presenting the deed to the chancellor, Mr. Lewis Fry expressed the profound satisfaction of the University that he had been able to accept the unanimous invitation to become its head. Lord Haldane, in the course of reply, remarked that he had spent a considerable part of his life and such energy as he possessed in endeavouring to forward the cause of the new civic university, and he hoped to be permitted to mould and fashion the operations of this great conception still further in the future.

In honour of the occasion, a large number of honorary degrees were conferred upon men and women distinguished in letters, art, science and public services. Lord Haldane himself received the patent of the honorary degree of LL.D., and among the other recipients of degrees were the following, who were presented in the order given.

M.Sc. (Engineering).—John Munro, professor of mechanical and mining engineering in the University.

M.D.S.—W. R. Ackland, lecturer in dental surgery in the University.

M.Ch.—N. C. Dobson, emeritus professor of surgery in the late University College, Bristol; J. P.

Bush, C.M.G., lecturer in operative surgery in the University.

M.Sc.—Herbert Bolton, director of the Bristol Museum and Art Gallery, and reader in palæontology in the University.

D.Sc. (*Engineering*).—W. Wilson, secretary for higher education to the County Palatine of Lancaster, formerly professor of electrical engineering in the Merchant Venturers' Technical College; H. S. Hele-Shaw, professor of engineering in University College, Bristol; J. Ryan, formerly professor of engineering in University College, Bristol; W. Ripper, dean of the faculty of engineering in the University of Sheffield.

M.D.—R. Shingleton Smith, emeritus professor of medicine in the late University College, Bristol; G. Munro Smith, formerly professor of physiology in University College, Bristol.

D.Sc.—Sydney Young, F.R.S., professor of chemistry in Trinity College, Dublin, formerly professor of chemistry in University College, Bristol; Silvanus P. Thompson, F.R.S., principal of the City and Guilds Technical College, Finsbury, formerly professor of physics in University College, Bristol; W. J. Sollas, F.R.S., professor of geology and palæontology in the University of Oxford, formerly professor of geology in University College, Bristol; Alderman Ernest H. Cook, chairman of the Education Committee of the City of Bristol; Sir Donald MacAlister, K.C.B., Vice-Chancellor of the University of Glasgow, president of the General Medical Council.

D.Litt.—T. H. Warren, president of Magdalen College in the University of Oxford, and professor of poetry in the same University.

LL.D.—D. S. Davies, medical officer of health for the city, county and port of Bristol, lecturer on public health in the University; F. Richardson Cross, special lecturer in ophthalmology in the University; Sir William Henry White, K.C.B., F.R.S., formerly Director of Naval Construction and Assistant Controller of the Royal Navy; Prof. J. Michell Clarke, pro-Vice-Chancellor of the University; Rev. T. Hamilton, Vice-Chancellor of the University of Belfast; Sir Henry R. Reichel, Vice-Chancellor of the University of Wales; Sir Alfred W. W. Dale, Vice-Chancellor of the University of Liverpool; Sir Alfred Hopkinson, Vice-Chancellor of the University of Manchester; the Right Hon. Sir William Mather, P.C.; the Right Hon. Sir Edward Fry, P.C., G.C.B., F.R.S.; the Right Hon. A. H. D. Acland, P.C., sometime vice-president of the Committee of Council on Education.

The following degrees were conferred *in absentia*, the recipients having been unavoidably prevented from attending the ceremony:—

LL.D.—The Prime Minister; the Right Hon. Arthur J. Balfour, P.C., F.R.S.

D.Sc.—Morris W. Travers, formerly professor of chemistry in University College, Bristol.

M.D.—R. Fletcher, librarian of the Surgeon-General's Library, Washington, editor of the "Index Medicus."

It was befitting that, in the presence of a chancellor who has, in more than one capacity, shown high skill in organisation, the proceedings should have been carried out with perfect precision from start to finish, thanks chiefly to the vice-chancellor (Sir Isambard Owen) and the registrar (Mr. James Rafter).

In the evening, Lord Haldane delivered his official address as Chancellor of the University before a large audience, taking as his subject "The Civic University." We give a few extracts from this address.

There was a time when men of business, accustomed to see closely to profit and loss, used to think that the work of a university was worth effort and expenditure only in so far as it produced aptitude for industrial and commercial production. Traces of this view are still apparent in the foundation deeds of some of the older university colleges of our municipalities. But this idea is now discredited, and the part played by science and by general learning in the production alike of the captain of industry and of the extension of invention is far greater than was the case even a few years ago. Applied science is in its best form only possible on a wide foundation of general science. And the fruitful scientific spirit is developed to-day on a basis of high intellectual training, the training which only the atmosphere of the fully-developed university can completely provide.

What is true of science in the narrower sense is also true of learning generally. It is only by the possession of a trained and developed mind that the fullest capacity can, as a general rule, be obtained. There are, of course, exceptional individuals with rare natural gifts which make up for deficiencies. But such gifts are indeed rare. We are coming more and more to recognise that the best specialist can be produced only after a long training in general learning. The grasp of principles which makes detail easy can only come when innate capacity has been evoked and moulded by high training. Our engineers, our lawyers, our doctors, our administrators, our inventors, cannot without it keep in front in the race. The competition is not merely with their fellow-countrymen; it is with the trained minds of other countries. These other countries are some of them advancing at least as rapidly as we are. An enlightened policy in education is the order of the day over most of the civilised world, and if we are to hold our own, even in the making of money, we are not to fall behind or lag in the endeavour to increase our efforts. We have more than ever before to see to it that we keep at least abreast in science, and science means far more now than technical training or the mere application of special knowledge to industry. It rests on a foundation of general culture which is vital to the maintenance of its standards, and it can develop only if the population has the fullest chance of an intellectual and moral training which goes deeper than mere science strictly so-called. It is the power of the highly trained mind that is required, and the full development of this trained mind can only be given by the highly organised universities.

A university to be a true university must be a place where the spirit is more important than the letter. The spirit of the university is the cooperation of professor and student in a common endeavour to learn. A university is a place where the most valuable advantage the student has is contact with an inspiring personality. That is why nothing short of the best level among the professors is enough for success. The professor must inspire. His labour must be one of love if he is to succeed. And if he is a great teacher he will have moulded the lives and tastes of the best of his students for the rest of their existence.

In Germany the technical colleges have been sharply divided from the university and given a separate existence. This is partly due to the division and separation in character of the great secondary schools in Germany. The resulting separation of the technical college from the university has been deplored by some of the most distinguished authorities on German education, notably by the late Prof. Paulsen. If this be a thing to be avoided we have avoided it. We have made our start by treating education as a single and indivisible whole—and by trying to keep the different kinds of students in one organisation. How powerful this tendency is we may see by the example of Cambridge. We have done even more, for we have developed in connection with our new universities a system of evening teaching for a separate class of student. That the tendency to recognise this kind of instruction as legitimate for the British university is increasing appears when we look at such cases as those of Glasgow and Manchester, where the great technical colleges of these cities are being brought into the closest relation with their universities. I believe this to be entirely right, and I am glad that you in Bristol took the same course at the beginning when you brought the Merchant Venturers' College, with its evening teaching, into your new University organisation.

Specialisation in each city university there will be and ought to be. *Non omnia possumus omnes.* In one place the distinctive strength will be in chemistry—general and applied—for exist without each other they cannot. In another, as in Sheffield, it will be the metallurgy of iron and steel; and it is not unimportant in this connection that Sheffield is the chief centre for the manufacture of the national guns and steel plates, an industry in which we dare not dispense with high science. In another place, as in the case of the Imperial College in London, we should have the great training place in the metallurgy of the precious metals for the students of a people which leads the world in their production. Some universities will be strong in engineering, civil and mechanical, or, it may be, marine. But the one thing requisite is that the broad foundations of the highest general knowledge should be there in each university, and that all specialisation should rest on these foundations. You cannot, without danger of partial starvation, separate science from literature and philosophy. Each grows best in the presence of the others. Another essential feature is adequate provision for the postgraduate student that is, the student who, having taken his degree, has in him the passion for excellence sufficiently strong to desire to continue in the university as a place of research and of the still higher learning which is inseparable from research. Such students may not be numerous, but when they are present they leaven the whole lump, and by their presence give a distinction to the university and to the professors under whom they work which could not be possible in their absence.

WILLIAM BOTTOMLEY.

THE death of William Bottomley at Glasgow on October 19, at sixty-three years of age, removes one who, throughout the greater part of his life, did genuine, unobtrusive service to the cause of applied science by the assistance he gave to his uncle, Lord Kelvin. A son of the late Mr. William Bottomley, of Fortbreda, County Down, and of Anna Thomson, the second of Lord Kelvin's sisters, Bottomley was trained as a civil engineer. In 1872, Sir William Thomson and Fleeming Jenkin undertook to act in partnership as engineers for the manufacture and laying of telegraph cables which were to connect the cities of the Brazilian coast, from the Amazon to the River Plate. Bottomley was put in charge of a staff of young assistants at the works of the Hooper Company at Millwall Docks where the cable was being made.

In those days there were no college laboratories which could compare with the testing-room of a cable factory as a scientific training ground for the practical electrician. The writer, who was a very junior member of the staff, well remembers Bottomley's cheery kindness, his capacity for management, and the ardour with which he threw himself into what was then a novel task. The art of cable testing, the necessities of which had been a chief factor in bringing into existence the scientific system of electrical units, was still undergoing evolution: new methods had to be devised, tested, and licked into shape for everyday use.

In 1873, Bottomley, along with his colleague W. F. King, accompanied Thomson and Jenkin in the maiden voyage of the cable ship *Hooper*, when the first section, from Para to Pernambuco, was laid. The sections from Pernambuco southward were laid in subsequent expeditions under their supervision, and in the absence of the chiefs.

Probably there are few parts of the later work of Kelvin in applied science with which William Bottomley was not in some degree concerned. With the Kelvin compass he had an early and intimate association. When the long struggle was over which preceded its general acceptance in the Navy and the mercantile marine, the task of looking after it as an article of manufacture and an object of business enterprise fell mainly on his shoulders. He had to train and superintend the skilled compass adjusters whose services were essential to its success. His own energy, his tact and judgment, and his appreciation of the scientific points at issue were in constant exercise for many years with the happiest results. The Kelvin compass came into universal use primarily, of course, because of its intrinsic merits; but these had to be demonstrated, defects had to be corrected, and prejudices to be overcome. In this work Bottomley's unfailing geniality, his simplicity and directness, and the warmth of his enthusiasm were valuable adjuncts to his technical knowledge: they were qualities, too, that endeared him to his friends.

J. A. E.

PROF. LEWIS BOSS.

IT is with deep regret that we have to record the death of Prof. Lewis Boss on October 5. While working as an assistant astronomer on the U.S. Northern Boundary Commission in 1877, Prof. Boss was greatly impressed by the urgent necessity for greater accuracy in star catalogues, and forthwith made the remedying of the defect his life-work; the immediate outcome was the extremely valuable "Boss's Declinations," in which, after discussing some hundred catalogues, he gave the declinations and proper motions of 500 stars for the epoch 1875. In 1878 he was appointed director of the Dudley Observatory, Albany, N.Y., a position which he held until his death, and after observing the corona at the solar eclipse of that year, he settled down to the solution of the many problems involved in the rigid determination of stellar positions. Generous friends showed their appreciation of Prof. Boss's labours by providing him with a new observatory in 1893, and later the Carnegie Institution of Washington showed practical sympathy with his work, also making him director of the Meridian Astrometry Department of the Institution.

Prof. Boss's publications are too many to refer to in detail here, but they dealt with many subjects such as the instrumental and magnitude errors in meridian work, the observation of comets, for which he published many ephemerides, and the determination of the sun's motion. In 1903 he published a standard catalogue of 627 stars distributed over both hemispheres, and in 1910 a preliminary general catalogue, in which he gave positions and proper motions of 6188 stars, of which about 4000 are brighter than the sixth magnitude.

The value of these researches is inestimable, but already many important results have accrued, such as the discovery of the Taurus stream of stars, and the value will rapidly advance as time passes. In 1905 the Royal Astronomical Society recognised Prof. Boss's work by presenting him with its gold medal, and in England, as elsewhere, the loss of a great and original investigator, and a personal friend, will be sorely felt. Prof. Boss was born at Providence, R.I., in 1846.

NOTES.

The Huxley lecture at the University of Birmingham is to be delivered on October 30 by Prof. John Joly, F.R.S., who has chosen as his subject "Pleochroic Halos."

The annual Huxley memorial lecture of the Royal Anthropological Institute will be held on Tuesday, November 19, at 8.30 p.m., at the theatre of the Civil Service Commission, Burlington Gardens, London, W., when Prof. W. Gowland, F.R.S., will deliver an address on "The Metals in Antiquity." Dr. Alfred P. Maudsley, president, will take the chair.

The Institute of Chemistry announces that Mr. E. White will deliver a lecture on thorium and its compounds on Friday, November 1, at 8 p.m., in the Chemical Lecture Theatre of Finsbury Technical College, London, E.C. Prof. R. Meldola, F.R.S., president of the Institute, will occupy the chair.

Prof. E. Metchnikoff, of the Pasteur Institute, Paris, will deliver a lecture on "The Warfare against Tubercle" in London on Friday, November 29, at 4.30, at the Royal Society of Medicine, Wimpole Street, Cavendish Square. The lecture is the Lady Priestley memorial lecture for 1912.

Much interest was aroused last March by the discovery of typical Upper Old Red Sandstone with fish remains beneath the neighbourhood of London. Mr. E. Procter, of the Imperial College of Science, exhibited to the Geological Society characteristic fragments of Holoptychius and Bothriolepis, which he had obtained from a depth of between 1100 and 1200 feet in a boring at Southall. He has lately presented these specimens to the British Museum (Natural History), where they are now to be seen among the fossil fishes.

Peabody Museum, Yale University, has received from the assistant professor of archæology, Dr. G. G. MacCurdy, the anthropological collections made by him during his summer visit to Europe. It has also acquired 2000 geological specimens gathered by Prof. C. Schuchert in Nova Scotia and the Lake Huron region, a collection made at Abydos in connection with the Egyptian exploration fund, and remains of a fossil three-toed horse found in Texas by Prof. R. S. Lull.

The death is reported, within a few days of his seventieth birthday, of Mr. Bradford Torrey, well known in America as a naturalist. He was a frequent contributor to *The Atlantic Monthly*, and was for several years one of the editors of *The Youth's Companion*. He had edited Thoreau's Journal, and was himself the author of "Birds in the Bush," "A Rambler's Lease," "The Foot-path Way," "A Florida Sketch-book," "Spring Notes from Tennessee," "A World of Green Hills," "Footing it in Franconia," "The Clerk of the Woods," "Nature's Invitation," and "Friends on the Shelf."

Dr. Morris Loeb, for several years professor of chemistry at New York University, died recently in his fiftieth year. He was a member of the executive committee of the International Congress of Applied Chemistry, which met a few weeks ago in America. His own research work was done chiefly in complex inorganic salts. Last year Dr. Loeb presented 10,000*l.* to the Walcott Gibbs Chemical Library at Harvard, of which university he was a graduate, and he was a generous benefactor of various scientific societies and Hebrew charities. He had been president of the Hebrew Technical Institute and of the Chemists' Club, and was a member of the New York Board of Education.

The death is announced, at sixty-eight years of age, of Mr. Robert Brown, fellow of the Society of Antiquaries, and distinguished by his works on comparative mythology. He was (says *The Times*) a student of Chaldæan myths, agreeing with Prof. Max Müller in tracing their origin to the movements of sun, moon, and stars, and the ebb and flow of natural phenomena, and opposing strongly the rival theory of totemism. His chief work, "The Great Dionysiak Myth" (two vols.), appeared in 1877–8, and he also published "The Myth of Kirke," "Aratus," "Researches into the Origin of the Primitive Constellations of Greeks, Phœnicians, and Babylonians," (two vols.), and "Semitic Influence in Hellenic Mythology."

We regret to learn from *The Times* that Prof. Otto Krümmel, who held the professorship of geography for many years at Kiel, and latterly at Marburg, and was recognised as the leading German oceanographer, died suddenly on October 12, at fifty-eight years of age. In 1911 he completed the publication of a standard treatise on oceanography, and he was joint author of the article, "Ocean and Oceanography," in the 11th edition of the "Encyclopædia Britannica."

As a member of the International Council for the Study of the Sea and of the Prince of Monaco's committee for the preparation of a chart of the depths of the ocean, Prof. Krümmel took a large share in promoting the recent advances in our knowledge of the ocean by international cooperation.

THE death is announced of Mr. James Parker, of Oxford, at seventy-nine years of age. Although best known as an antiquarian, Mr. Parker was an industrious student of geology, and made a remarkable collection of fossils from the neighbourhood of Oxford, including Teleosaurian skulls and a Megalosaurian skeleton described by Phillips in his "Geology of Oxford." For fifty years he was an active member of the Geologists' Association, and in 1876 he contributed to their Proceedings a paper on the valley of the Somme, France. In 1880, for the use of one of their excursions, he also published a map and sections of the strata south of Oxford. Earlier in life he was associated with Prof. Boyd Dawkins and the late Mr. Ayshford Sanford in the exploration of caves in Somersetshire, and he devised a raft for the navigation of underground waters.

ON Wednesday, October 16, a new gallery, which is to be entirely devoted to the illustration of local mammals, was opened at the Municipal Museum, Hull. The specimens include several historical examples from the collection of the late Sir Henry Boynton and other sources, and a number of them are the last records of the kind for the district. The collection is arranged in specially made cases, in which the animals are shown in their natural surroundings, in addition to which there are several large groups showing male, female, and their young, &c. The groups consist of otters, badgers, hedgehogs, deer, foxes, &c. On the occasion the curator, Mr. T. Sheppard, gave an address on the mammals of the East Riding of Yorkshire.

WE are informed that a new society, which has assumed the title of the South African Association of Analytical Chemists, has recently been formed, with headquarters in Johannesburg. The main objects of the association are to uphold the status and the interests of the profession of technical chemistry and to secure a high standard of professional conduct amongst analysts in South Africa. In its constitution the new association has made provision for undertaking any procedure which will encourage the study or extend the knowledge of analytical and technical chemistry. The first council of the association is:—*President*, Dr. J. McCrae; *Vice-President*, G. H. Stanley; *Honorary Treasurer*, A. Whitby; *Members*, Dr. R. B. Denison, J. Sprunt Jamieson, Dr. C. F. Juritz, Dr. R. Marloth, Dr. J. Moir; *Honorary Secretary*, Jas. Gray, P.O. Box 5254, Johannesburg.

THERE has recently been added to the exhibits in the Shell Gallery of the Natural History Museum a working model illustrating the phenomenon of "torsion" in Gastropod Mollusca. The model can be easily operated by the public, and exhibits the process of "torsion" in two stages. Two diagrammatic models of shells in skeleton outline, containing intestine and visceral commissure of the nervous system, are rotated successively by handles. The first model thus operated illustrates the production of the U-shaped flexure of the intestine by the approximation of the mouth and anus. The second shows the actual "torsion" of the intestine and visceral commissure. The model is diagrammatic and generalised, and does not attempt to suggest a cause for this phenomenon.

AT the annual meeting of the Royal Society of South Africa, held at Cape Town on September 18, the president, Dr. L. Peringuey, announced that the council had awarded the following grants-in-aid of research:—To Mr. E. J. Hamlin, of Cape Town, 90*l*., to carry on research on commutation in electrical machinery; to Mr. A. Young, of Cape Town, 20*l*., to continue investigations on a fluctuating well in the Karoo; to Mr. P. A. Methuen, of Pretoria, 50*l*., for a journey to the Great Karasberg Range for the study of the taxonomy and distribution of the lower vertebrates and several groups of the invertebrates of Great Namaqualand; to Mr. G. Rattray, of East London, 50*l*., for travelling expenses in connection with the continuation of the investigation of the taxonomy and distribution of South African Cycads; to Miss E. L. Stephens, of Cape Town, 15*l*., for (*a*) determination of South African fresh-water Algæ, (*b*) periodic change in fauna and flora of certain South African vleis; to Miss A. W. Tucker, of Johannesburg, 50*l*., for an ethnological survey of the Topnaar tribe of Hottentots.

AMERICAN naturalists are delighted by the announcement that Mrs. Russell Sage, widow of the late well-known Wall Street financier, has purchased Marsh Island, off the coast of Louisiana, in order to make it a perpetual bird sanctuary. "With one penful of ink," says Mr. W. T. Hornaday, in an enthusiastic letter to the American Press, "Mrs. Russell Sage has taken the greatest bird-slaughtering ground of the Gulf Coast away from the market gunners of Louisiana and dedicated it for ever to the opposite cause—the preservation of the birds of North America." The island in question is about 75,000 acres in extent. It is a sylvan labyrinth affording shelter and food to hundreds of thousands of wild birds which resort to it in winter when the northern lakes and streams are locked fast under ice. For this reason it has been the great killing ground for the markets of New Orleans, St. Louis, Cincinnati, and Chicago, no fewer than seventy market gunners being regularly employed there every winter. The price paid by Mrs. Sage for the island is 30,000*l*. This is said to be the second largest gift ever made for the protection of wild life in America, the largest being the bequest of 62,400*l*. by Mr. David Wilcox to the National Association of Audubon Societies.

THE Harveian Oration before the Royal College of Physicians was delivered on October 18 by Sir James Goodhart, who took for his subject "The Passing of Morbid Anatomy." Are physicians, he asked, sufficiently alive to the fact that pathology is no series of stationary phenomena, but constantly on the move, like all else in nature? What alterations have not been seen in forty years? Pyæmia may be said to be wiped out; typhus is well-nigh forgotten; typhoid fever has altered; diphtheria seldom attains the initial severity that so often characterised it of yore and is much more amenable to attack; scarlatina is of a much milder type; erysipelas is more of a rarity; malaria and Malta fever have been run to earth; the late results of syphilis seem to be far less often in evidence; lardaceous disease, so very common in earlier days, is now seen but seldom; and doctors have come at grips with acute rheumatism and, it is to be hoped, with tuberculosis. Probably as much might be said of other diseases, and good old age is both more prevalent and more enjoyable. Dealing with the future of pathology, Sir James Goodhart went on to say fatigue is a disease nowadays. All know the machine that will not spark aright. There is nothing to be called structural change, and even rest furnishes no remedy. It is clear that what is required is a fresh stock of some form of energy for charging up the machine that doctors are as yet not able to supply—so far away, and yet perhaps so nigh.

The new medical school attached to the Royal Hospital for Diseases of the Chest, City Road, London, was formally opened on October 17, when Prof. Nietner, of Berlin, delivered the inaugural address. He pointed out that the researches of the last ten years have brought to light facts that indicate that in a large majority of cases tuberculosis infection occurs during childhood, in the first years of life. Hamburger has declared that 90 per cent. of all children up to the completed twelfth year are infected. Schlossmann has gone so far as to say that tuberculosis is a true children's disease, is acquired during childhood, and must be prevented, treated, and healed during childhood. It is a fact that in by far the greater number of cases the source of infection can be traced to the human subject's suffering from "open" tuberculosis, and that infection is acquired through the close intercourse resulting from family life. Only those preventive measures can hope for success which take this fact consistently into account. But to prevent the child from becoming infected in his own home environment without weakening family ties and responsibilities offers a social problem of the utmost complexity. Tuberculosis is not a "school disease," and the school cannot justly be held responsible for the spread of infection. Finally, the lecturer said he attaches great value to the use of tuberculin in the treatment of tuberculous children, and claimed good results from it if properly administered.

Mr. H. Ling Roth, honorary curator of the Bankfield Museum, Halifax, has republished as No. 1 of the second series of "Museum Notes," his paper on Oriental steelyards and bismars, reprinted from vol. xlii. of the Proceedings of the Royal Anthropological Institute. The original centres of distribution of these instruments seem to be China and Japan, whence they spread to the ports of the Malay Peninsula and India, and thence to Europe. Neither the Babylonians nor the Egyptians, until Roman times, seem to have possessed them, and an English specimen of the seventeenth century, now in the Horniman Museum, preserves the characteristic Chinese turnover arrangement. The paper, with its abundant illustrations and careful description of the different varieties, forms an interesting chapter in the transmission of culture.

The September issue of *The National Geographic Magazine* is entirely devoted to an elaborate account, illustrated by an excellent series of photographs, of the head hunters of northern Luzon, by Mr. Dean C. Worcester, Secretary of the Interior of the Philippine Islands, who has already done much to elucidate the ethnology of the islands. Hitherto it has been supposed that the custom of head-hunting did not prevail among the Negrito tribes; but Mr. Worcester's exploration of their last important stronghold proves that this is a mistake. The difficulty of social intercourse with them is increased by the barrier reef which guards their coast. Besides the Negritos, this article contains an interesting account of the Ilongot, Kalinga, Ifugao, Bontoc, and Tingian tribes, who, in spite of various savage customs, have in certain directions attained a fairly high degree of culture. This valuable monograph on a little-known people deserves the attention of anthropologists.

The report of the Committee on Ancient Earthworks and Fortified Enclosures, prepared for presentation to the Congress of Archæological Societies, indicates that there were during last year more cases than usual of damage, or destruction, actual or threatened, to the structures under their care. Unfortunately, most of the damage has occurred during the construction of golf links, and the committees of such clubs have been urged to use their influence for the protection of prehistoric remains. It is also unpleasant to learn that Irish tenants who have acquired ownership of their farms under the Land Purchase Acts frequently destroy ancient earthworks, and that workmen, who some years ago, through fear of the fairies, would not touch such remains, are losing their superstitious belief. On the other hand, among the more intelligent members of the community in both islands there is an increasing desire for protection, and the Royal Commission on Ancient and Historical Monuments in England and Wales is collecting much valuable information, and is exciting public opinion towards their conservation.

In *The Victorian Naturalist* for September, Miss J. W. Raff describes the female of *Phreatoicopsis terricola*, a genus and species of isopod crustaceans previously known only by the male. It is remarkable that the species occurs in two isolated mountain areas —the Grampians and the Otways—which are about one hundred miles apart, and separated by a broad, dry valley, entirely unsuited to the habits of this isopod, which is restricted to forest.

In an article of sixty pages on Japanese cephalopods (in which all the known species are enumerated), published in the Proceedings of the Philadelphia Academy for July, 1912, Mr. S. S. Berry emphasises the remarkable resemblance between this fauna and the cephalopod fauna of the Mediterranean, although in its general character the former is nevertheless distinctly Indo-Malay. Apart from Loligo and Sepia, which are extraordinarily rich in peculiar forms, there are, indeed, remarkably few exclusively Japanese species. The presence of the group of species allied to *Polypus*, or *Octopus*, *honkongensis* suggests an invasion from the Aleutian-Californian province, although this is by no means certain.

IN an article on the cultivated and wild forms of cochineal insects, published in the September issue of *The Journal of Economic Biology*, Mr. E. E. Green protests against the transference of the name Coccus from these insects to another genus, and the substitution of Dactylopius. In retaining *Coccus cacti* for the typical cochineal insect, he will gain the approval of those naturalists who consider that familiar zoological names, which give an obvious clue to the animals they represent, ought not to be displaced. It is pointed out that the Indian cochineal insect, for which the author proposed the name *C. indicus* in 1908, was originally imported from Brazil in 1795, other importations being made subsequently. Nevertheless, it cannot apparently be identified with any American form, and therefore seems to indicate the development, within a century, of a new species, as the result of changed environment.

THE September number of *The Quarterly Journal of Microscopical Science* (vol. lviii., part 1) contains an important paper by Prof. G. E. Nicholls on the structure and development of Reissner's fibre and the subcommissural organ. Prof. Nicholls gives a very useful historical review of our knowledge of these remarkable structures, and severely criticises Sargent's work on the subject. He then passes on to a detailed account of Reissner's fibre and the subcommissural organ in the Petromyzontidæ and Myxinoidei, illustrated by a number of diagrams and some very remarkable photomicrographs. In the same number Mr. Geoffrey Smith publishes the ninth part of his "Studies in the Experimental Analysis of Sex." He finds that in hybrid pigeons, of which only males were obtained, the ripe spermatozoa are of about twice the normal size. This is explained by abnormalities in the process of spermatogenesis. In the first maturation division, the chromosomes, instead of forming the normal eight synaptic pairs, are irregularly distributed on the nuclear spindle, while the second maturation division is suppressed. Mr. Smith thus confirms the previous observations of Guyer, and adopts his view that the sterility of such hybrids is due to the inability of the chromosomes derived from specifically different parents to form the normal synapses.

WE have received a revised and enlarged edition of a neo-vitalistic essay by Prof. Moriz Benedikt, of Vienna. It is entitled "Biomechanik und Biogenesis" (Fischer, Jena, pp. 88), and deals in a somewhat esoteric, not to say eccentric, fashion with the problems of vitality. The author has devoted special attention to "action at a distance" in the life of organisms, to a monistic interpretation of psychical activity, and to the origin of living substance. As to the last, it probably occurred for the first time in the meshes of colloidal sea-sand, and the composition of our blood-serum is a hereditary reminiscence of the primeval cradle of life. But living matter has undoubtedly continued to be formed, else the organic world would long since have eaten itself up. Whether the results of present-day natural synthesis (which eludes our observation) attain to the level of the very simplest organisms we know, is questionable. But it is difficult to be quite sure when the genial author is not poking fun at us. "Biomechanik" is another word for "neo-vitalism," and Prof. Benedikt's general position is that the ordinary physical, mechanical, and chemical laws hold good for vital processes, but (to use his phraseology) do not completely dominate them. Laws "of a higher order" hold good in the realm of life—laws which cannot be deduced from those of the inanimate world. The movements of corpuscles in living matter are much more intricate than those in not living matter, and the author is especially concerned with the structural configurations that have made vital activities possible.

THE Pliocene deposits contain the key to many problems of modern animal distribution, including the centres from which man spread across the earth. Workers in European natural history will especially welcome Dr. J. P. Tesch's handsomely printed memoir, "Beiträge zur Kenntnis der marinen Mollusken im west-europäischen Pliocänbecken" (*Med. van de Rijksopsporing van Delfstoffen*, No. 4, The Hague, 1912, and Craz and Gerlach, Frieberg in Sachsen, price 6 marks). A list and commentary on the distribution of the known molluscan species of the area occupy the greater part of the paper, and considerable use is made of information obtained from borings in Holland.

THE new phenomenon Prof. Righi brought before the Academy of Science of Bologna in January, to which he gave the name of ionomagnetic rotation, is described in detail in the Memoirs of the academy and in the *Physikalische Zeitschrift* for August. If a spark from a condenser of considerable capacity is sent horizontally through a gas and two small vertical vanes of mica in the form of a cross are suspended in the middle of the discharge by a fine fibre attached to the centre of the cross, the spark produces no rotation of the cross. If, however, a vertical magnetic field is established in the gas the cross rotates through a considerable angle if the gas is air, and over a small angle in other gases. Prof. Righi ascribes this rotation to the bending of the paths of the ions or electrons and to the additional protection which the vanes afford each other against impacts from one side rather than from the other in these circumstances. The observed rotations indicate that the effects of the positive ions are in general greater than those of the negative.

A GENERAL lecture, delivered by Prof. G. Ciamician before the International Congress of Applied Chemistry in New York, is reprinted in *Science* for September 27, under the title, "The Photochemistry of the Future." At the outset some interesting suggestions are advanced as regards the utilisation of the solar energy in the days when our coal deposits shall be exhausted, and then the author describes briefly some of the principal results obtained by himself jointly with Profs. Silber and Ravenna, at the University of Bologna, in the study of photochemical action. In a series of recent experiments made to determine the physiological function of the glucosides, it was found possible to force maize, a plant which is normally free from the substance, to synthesise salicin, whilst the production of nicotine by the tobacco plant can be controlled so as to obtain a large increase or decrease in the quantity of this alkaloid. The possibility is suggested by these experiments of greatly increasing the proportion of the useful constituents of plants by a suitable treatment during the period of their growth.

Under the title "Une Loi Universelle," Prof. Wilden D. Bancroft publishes an interesting article in the *Revue Scientifique* for September 28, on the well-known theorem of Le Chatelier, for which he claims a wider application than it is generally credited with. He considers that this law, which in physics becomes the principle of least action, in biology becomes the law of the survival of the fittest, and in economics the law of supply and demand. In its most general form the law is stated by Prof. Bancroft in the following terms: The changes which affect a system are such that they tend to render minimum the disturbance of external origin. A number of cases are cited in which the principle is extended to vital phenomena, more particularly as regards the adaptation of plants and animals to temperature, light, humidity, and climate, and in exnlanation of the origin of variations. The position taken up is that no variation is spontaneous, but that if we go far enough back all variations are the result of changes in external conditions. The real problem in such cases is to show, for any given organism and any given variation, what part has been played by external conditions on the preceding generation, and the part played by conditions on the generations which preceded that one.

In the annual report of the Minister of Mines of British Columbia, just published, the reported discovery of metals of the platinum group in certain dykes near Nelson in that province is discredited. As a result of numerous analyses carried out, at the request of the Minister by various experts in America and Europe, on samples carefully taken from the portions of the dyke in which the presence of platinum metals had been reported, the complete absence of these metals was established. In none of the samples was any trace found either of any of the platinum metals or of anything corresponding with the supposed new metal, "canadium," the reported discovery of which was announced in these columns about a year ago.

The issue of *The Philippine Journal of Science* for July last takes the form of a memorial number to the late Dr. Paul Caspar Freer, who was director of the Bureau of Science of the Government of the Philippine Islands, dean of the college of medicine, and professor of chemistry of the University of the Philippines. Dr. Freer was also the founder and editor of *The Journal of Science*. This issue of the magazine contains eight appreciations of Dr. Freer's life and work. Mr. Martin Egan, editor of *The Manila Times*, writes of his life and career; Bishop Brent of his influence upon other men; Mr. R. P. Strong, chief of the biological laboratory in the Bureau of Science, describes his general influence upon scientific work in the Philippine Islands; Mr. Dean C. Worcester, secretary of the Interior of the Government of the Islands, gives an account of his work for the Bureau of Science; Mr. W. E. Musgrave, of the General Hospital, of his work for the university; Mr. Murray Bartlett writes of him as an organiser and administrator; Prof Calderon as a friend of the Filipinos; and Prof. H. D. Gibbs as a chemist.

A revised edition of Dr. J. G. Bartholomew's "School Economic Atlas," to which Prof. L. W. Lyde contributes an introduction, has been published by the Oxford University Press. The price of the atlas is 2*s*. 6*d*. net.

In the note on the first report of the Meteorological Observatory at Montserrat (Nature, September 12, p. 59), it should have been added that the daily maxima and minima of temperature were given in separate tables on other pages in conjunction with the values of humidity.

The presidential address delivered last September to the British Association, at its meeting at Dundee, entitled "Life: its Nature, Origin, and Maintenance," has been published in pamphlet form by Messrs. Longmans, Green and Co. at the price of 1*s*. net.

The most recent issue of the botanical catalogue of Messrs. John Wheldon and Co., of 38 Great Queen Street, Kingsway, London, gives particulars of some 1700 books and papers on various branches of botany. Many recent purchases and selections from several important libraries are included.

A fourth edition of the late Prof. Thomas Preston's "Theory of Light" has been published by Messrs. Macmillan and Co., Ltd. It has been edited by Prof. W. E. Thrift, and its price is 15*s*. net. The developments that have taken place since the publication of the third edition, in 1901, have led Prof. Thrift to make additions, which are suitably indicated. A fuller treatment of dispersion is given, an account of radiation phenomena in a magnetic field, and a more complete presentation of the electro-magnetic theory, which is dealt with from the electron point of view of Lorentz and Drude.

OUR ASTRONOMICAL COLUMN.

The Discovery of a Comet, 1912*b*.—A telegram from the Kiel Centralstelle announces the discovery of a comet by M. Schaumasse, at Nice, on October 18. The position of the object at 17h. 5m. (Nice M.T.) on that date was:—

$$\text{R.A.} = 9\text{h. } 57{\cdot}6\text{m., decl.} = +1^\circ\ 36',$$

and the motion was easterly. The magnitude was 11·5, and the position given lies in Sextantis, about 11° south of Regulus, thus rising about 2.30 a.m.

A second telegram from the Centralstelle states that

MM. Fayet and Schaumasse find the elements of the orbit of this object to be almost identical with those of Tuttle's comet.

COMET 1912*a* (GALE).—The following set of elements for the orbit of comet 1912*a*, from which he derived the corrected ephemeris we gave last week, is published by Dr. Ebell in No. 4604 of the *Astronomische Nachrichten*; it is based on observations made on September 8, 17, and 26:—

$$T = 1912 \text{ October } 4{\cdot}95917 \text{ M.T. Berlin.}$$
$$\left.\begin{aligned} \omega &= 25^\circ\ 33'\ 37{\cdot}9'' \\ \Omega &= 297\ \ \ 2\ \ \ 53{\cdot}3 \\ i &= 79\ \ \ 51\ \ \ 10{\cdot}2 \end{aligned}\right\} 1912{\cdot}0$$
$$\log q = 9{\cdot}854958$$

A further extract from the ephemeris is given below:—

Ephemeris 12h. M.T. Berlin.

1912	α (true) h. m.	δ (true)	1912	α (true) h. m.	δ (true)
Oct. 25	15 57·0	+19 20·5	Oct. 29	16 0·5	+22 26·5
26	15 57·9	+20 8·1	30	10 1·3	+23 11·1
27	15 58·8	+20 55·0	31	16 2·1	+23 55·2
28	15 59·6	+21 41·1	Nov. 1	16 3·0	+24 38·7

During the period covered by this ephemeris the calculated decrease in magnitude is 0·5.

MEASURING THE ANGULAR DIAMETERS OF STARS.—In No. 2, vol. xxxvi., of *The Astrophysical Journal*, Dr. Pokrowsky suggests a method whereby it should become possible to measure the angular diameters of stellar objects, a result which, if obtained directly, would greatly widen our knowledge of stellar physics. The method is too technical in detail to be given here, but it depends upon the consideration that if two rays emanate from different points on the surface of a distant light-source, such as a star, there will be a difference of phase depending upon the distance between the two points. These two systems of rays after polarisation form two images of different intensities in the focus of a telescope, and Dr. Pokrowsky shows that by measuring the difference of intensity the angular diameter of the star may be derived; thus the problem is reduced to one of stellar photometry, and it is calculated that for bright stars, such as Arcturus, Canopus, Capella (average magnitude, say, =0·0), angular diameters of 0·0031″ might be discovered. As the method would be very sensitive, atmospheric conditions would greatly interfere, and the apparatus could only produce positive results at a mountain observatory.

THE PERSEIDS OF AUGUST 12, 1912.—Some interesting data concerning the meteor shower of August last are given by Prof. Zammarchi, in No. 10, vol. i. (2nd series), of the *Memorie della Società degli Spettroscopisti Italiani*. The observations were made at the meteorological observatory attached to the seminary at Brescia, and in a total of 13·6 hours, spread over the nights of August 10, 11, 13, and 14, six observers recorded 170 meteors. The greatest horary rate occurred on August 11, when 93 meteors were seen in four hours; on August 12 the sky was covered and observations impossible. For each meteor the time, the magnitude, and the appearance are given, and in many cases the position of the beginning and end of the path.

THE PHYSICAL CAUSE OF THE z-TERM IN LATITUDE VARIATION.—A possible cause producing the z-term in latitude variation is suggested by Mr. S. Shinjo in a paper of which we have received a reprint from the *Tôkyô Sûgaku-Buturigakkwai Kizi* (second series, vol. vi., No. 16), published by the Tokio Mathematico-Physical Society. Putting on one side, as unlikely, the possibility of its being due to systematic error in the observations and the suggestion that it is due to real changes in the earth, Mr. Shinjo reverts to the probability that the z-term is introduced by the action of anomalous refraction. But no such inclination of the atmospheric strata as is necessary to produce the anomalous refraction has been observed over any large area. Mr. Shinjo, however, inquires into the purely local conditions appertaining to and immediately surrounding the observing station, and suggests that in these very localised areas the atmospheric gradient is frequently sufficiently sharp; for example, the difference in temperature between the sun side and the shade side of the observing hut might produce a pressure-gradient sufficient to produce the z-term. He concludes that the greater part of the term is probably produced by this cause, about one-fourth as a consequence of the daily variation of the pole, as remarked by Sitter, and a small part may possibly be due to real change in the earth.

THE BECQUEREL MEMORIAL LECTURE OF THE CHEMICAL SOCIETY.

AN extra meeting of the Chemical Society was held on Thursday, October 17, when Sir Oliver Lodge, F.R.S., delivered a memorial lecture in honour of Antoine Henri Becquerel, late honorary and foreign member of the Chemical Society. Prof. Percy F. Frankland, F.R.S., president of the society, occupied the chair.

Sir Oliver Lodge referred to the changes that of recent years have come over physical science. Not many years back its progress appeared to be placid, along well-worn channels, and based upon the substantial knowledge of the past. To-day it is characterised by intense speculative activity on the one hand, and, on the other, by exceptional scepticism.

Discoveries are of two chief kinds: the discovery of law and the discovery of fact. The discovery of law often leads to the discovery of new facts, and the discovery of new facts to either the formulation of new laws or new modes of statement, or to the resuscitation of discarded ones. As examples of the discovery of law may be instanced Newton's gravitational theory of astronomy, Maxwell's electro-magnetic theory of light, the atomic theory of chemistry, and the conservation of energy. As examples of the discovery of fact may be quoted the prehistoric discovery of flame, the discovery of static electrification, of the electric current, of magneto-electricity, of the electron, and of spontaneous radio-activity.

Of the scientific discoveries made during the past fifty years, that of the Röntgen X-rays perhaps created the most widespread interest; but even more striking and revolutionary was Becquerel's discovery of the spontaneous radio-activity of matter, for the spontaneous splitting up of atoms and the consequent expulsion of constituent fragments was not provided for on any theory.

A discovery of essential novelty cannot be made by following up a train of prediction. It is often made during the process of following a clue, but the clue does not logically lead to it. A really new fact comes as a side issue something unexpected and that might have been overlooked. The discovery which has been pointed to by theory is of great value, but it is usually the outcome of a long and fruitful period; whereas the discovery which comes as a surprise generally marks a fresh epoch, and opens a new chapter in science.

So with the discovery of spontaneous radio-activity. Becquerel was looking for the possible emission of Röntgen rays by a fluorescent substance. It was a reasonable thing to look for, and had it been found would have made an interesting extension of our knowledge; but, when critically examined, the kind of radiation turned out to be for the most part not Röntgen rays, but corpuscular, and to have nothing to do with fluorescence.

Becquerel set himself carefully to examine the kind of penetrating radiation which fluorescent substances exposed to light might be found to emit. Though not finding that for which he sought, he made a discovery of far greater importance.

After giving an account of the recent discoveries in radio-activity, the lecturer dwelt on the present trend of scientific thought; of the tendency to return to discarded hypotheses such as spontaneous generation and the corpuscular theory of light. Our attitude amongst so many conflicting hypotheses should be to admit that any law applicable to concrete objects and established by induction on a basis of experience must be of the nature of a postulate; that we should hold some of the postulates as so well-established that arguments necessitating their overhauling should, *ipso facto*, to that extent be discredited, and should not receive our encouragement unless supported by new facts. Our endeavours should be to harmonise new facts with the firmly established laws of physics until compelled to look for some higher generalisation.

Reference was then made to some of the well-established laws, and to the attempts to construct living matter from artificially combined materials. Life demands energy for its manifestations, and radio-activity may be suggested as a possible source of such energy. It is known that atoms give off energy as they disintegrate; that organic compounds likewise disintegrate and evolve energy, finally becoming inorganic. A decaying heap of refuse represents a close chemical analogy to the physical activity of uranium—one is an affair of atoms, the other of molecules. This stock of energy running to waste seems eligible for guidance. Life has to control this spontaneous disintegration of protoplasmic cells, to regulate the activity of the ganglia in the brain, for instance, or to suspend the disintegration of organic material until some appointed time, and then to direct it along some determined channel. We have yet to discover how life achieves this control. Those who say that life cannot guide material processes unless it is itself a form of energy, and those holding that life cannot act at all unless energy is at its disposal, forget the spontaneous activity of complex organised molecules and the atomic disintegration manifested by radio-activity.

There is a great difference between matter potentially living and actually alive. In the physical universe our power is limited to the movement of matter; after that, all that happens is due to the properties of matter and its ethereal environment. If potentially living matter is ever artificially made by placing things in juxtaposition and bringing physical resources to bear upon the assemblage, then it may become alive. If this last step be taken, it will be because something beyond matter, something outside the region of physics and chemistry, has stepped in and utilised the material aggregate provided. Only in this sense did the lecturer consider that the artificial incarnation of life would be possible. Some day life may appear under observation, but it will not be manufactured, any more than radium or radio-activity has been manufactured.

Sir Oliver Lodge spoke of the tendency of present-day science to materialise the invisible, quoting, among other examples of this, the fact that plague, which in olden times was attributed to such mysterious causes as a conjunction of the planets, the iniquities of the Jews, &c., is now known to be due to a minute vegetable parasite living on the fleas of rats.

The scientific life and work of Antoine Henri Becquerel were then dealt with, and an account given of his chief discoveries. A vote of thanks to Sir Oliver Lodge, proposed by Sir William Crookes, O.M., F.R.S., seconded by Prof. Henry E. Armstrong, F.R.S., and supported by the president, was briefly acknowledged by the lecturer.

THE RELATIONS BETWEEN VARIOUS SOLAR PHENOMENA.

TWO papers recently published in the *Comptes rendus* (No. 10, September 2, and No. 12, September 16), by Prof. Riccò and M. Deslandres respectively, contain several very important statements, concerning the interrelations of such solar phenomena as *filaments, alignements*, prominences, spots, &c., which no student of solar physics can afford to neglect, and which we briefly summarise below.

Prof. Riccò, having studied his valuable records of limb prominences and also those published by Wolfer, finds that the prominences frequently appear in the same position on the sun's limb for several consecutive days, and so must form files of prominence activity across the disc, strongly resembling M. Deslandres's filaments and alignments; he also finds limb prominences recorded at the time and in the positions indicated by M. Deslandres's filaments and alignments. He concludes that there is an indisputable connection between the two sets of phenomena. With sun-spots, however, he finds no connection with the filaments and alignments. But in his paper M. Deslandres considerably modifies this latter conclusion of Prof. Riccò's, and states that there is a general connection, the several phenomena obviously belonging to one system and reacting on each other.

M. Deslandres, in order to make the investigation more precise, gives further important results concerning the filaments and alignments shown on his wonderful series of photographs. He agrees that a prominence on the limb generally means a filament or alignment joining the limb at that point. The relation between the two sets of phenomena is confirmed. Further, he differentiates more clearly between filaments and alignments, the former being a special case of the latter, which cover much greater lengths. Alignments vary in intensity from feebly bright to very dark, and then merge into filaments which are exceptionally black and well defined. The alignments are frequently bordered, diffusely, with parallel bright lines, whereas the filaments are clearly-cut lines. Filaments are found on both the "hydrogen" and the "calcium" photographs, most strongly marked on the former, whereas alignments are, in general, only found on the "calcium" photographs. The brightest prominences occur at the ends of these bright companions of the alignments, and are, therefore, as Prof. Riccò also points out, not symmetrically placed with regard to the central dark alignment. Prof. Riccò suggests that this asymmetry is due to the fact that while the prominences are emission, the alignments are absorption, phenomena, and thus the two things probably represent activity in different layers of the solar atmosphere.

M. Deslandres suggests that the restriction of alignments to the "calcium" photographs, whereas the filaments are better shown on the "hydrogen" plates, may be due to the fact that the filaments probably exist at higher levels, not so readily reached by the calcium vapours. He also suggests that those eruptive prominences not connected with spots are intimately connected with filaments, and in his radial-velocity researches has found that these two phenomena are alike in showing an ascensional radial velocity.

The importance of these researches is obvious, and the results likely to accrue from the simultaneous study of the forms and velocities of the various features most valuable, but, as M. Deslandres points out, it will only be possible to state general and definite laws when continuous and complete observations have extended over at least one undecennial period of solar activity.

THE SIGNIFICANCE OF LIFE TO THE OMAHA.[1]

FOR twenty-nine years Miss Alice Fletcher has been studying the Omaha, and her monograph of the tribe is now published in the twenty-seventh Annual Report of the Bureau of American Ethnology. Her collaborator for most of this time was Mr. Francis La Flesche (the son of Joseph La Flesche, former principal chief of the tribe), who in his boyhood witnessed some of the ceremonies described in the memoir, which were later explained to him by his father and by the old men who were the keepers of these ancient rites and rituals. When Miss Fletcher first went to live among the Omaha, the tribe had recently been forced to abandon hunting owing to the sudden extinction of the herds of bison. All the men and women had participated in the old life, many of the ancient customs were practised, and much of the aboriginal life still lingered. The environment was changing quickly; all that they formerly had relied on as stable had been swept away; the bison, which they had been taught was given them as an inexhaustible food supply, had been destroyed by agencies new and strange; even the wild grasses that had covered the prairies were changing. Great unrest and anxiety had come to the people through the Government's dealings with their kindred, the Ponca tribe, and fear haunted every Omaha fireside lest they, too, be driven from their homes and the graves of their fathers. The future was a dread to old and young. Thanks to the strenuous efforts of Miss Fletcher on their behalf, a law was enacted in 1882 granting lands in severalty, and prospective citizenship. In 1802 the Omaha were reduced to about 300 by smallpox; twenty-seven years later they were said to number 1900; in 1906 the population of the tribe was 1228. The past is overlaid by a thriving present. The old Omaha men and women sleep peacefully in the hills while their grandchildren farm beside their white neighbours, send their children to school, speak English, and keep bank accounts.

"In the account here offered," Miss Fletcher says, "nothing has been borrowed from other observers; only original material gathered directly from the native people has been used, and the writer has striven to make, so far as possible, the Omaha his own interpreter." The most important previous accounts of the tribe are the Rev. J. Owen Dorsey's "Omaha Sociology," published in the third Annual Report of the Bureau in 1884, which ever since has been largely quoted, and his paper on "Omaha Dwellings, Furniture and Implements" (the thirteenth Report, 1896). It will be found that there are many discrepancies between Dorsey's and Miss Fletcher's statements. For example, Dorsey says that the Black Shoulder clan were originally bisons ("buffaloes") and dwelt under the surface of the water, but Miss Fletcher writes, "no Omaha believes that his ancestors ever were elk, or buffalo, or deer, or turtle, any more than that they were the wind, the thunder, or the sky" (p. 601).

As has just been stated, Miss Fletcher gives us only first-hand matter, which she has carefully sifted and verified so far as possible. She evidently did not like to criticise or correct Dorsey's statements; there can, however, be little hesitation by students which account they should follow when discrepancies occur. On account of the great changes that have taken place in the material, social, and religious life of the Omaha it is improbable that anything of importance can be gleaned by future workers, and much that Miss Fletcher describes will then be unobtainable. Her monograph, the result of arduous and protracted toil, is the record by a field worker of wide sympathy and insight of investigations which were begun at the critical time of incipient disintegration and while the old knowledge was still fresh in the minds of the people. Some American ethnologists even go so far as to say that she reads into the native mind ideas that it does not contain, but the more we learn about the North American Indian the more apparent it is that he is imbued with a rare spirituality, and it is a common experience that one field observer will discern what another cannot see, as an old writer has said, "The natural man receiveth not the things of the Spirit of God: for they are foolishness unto him: neither can be know them, because they are spiritually discerned." Doubtless Miss Fletcher is content to leave this matter to the arbitration of the intensive study of the religion of allied tribes.

The legendary home of the Omaha and cognate tribes was in the east, "near a great body of water," and the legend gives an interesting account of cultural evolution, due partly to invention and partly to borrowing from other tribes. All children passed through a ceremony of turning, which was directly related to the wind, earth, and fire, whereby it was introduced to the tribe. Later a lock of the boy's hair was cut off and given to Thunder; thereby the life of the child was given into the keeping of the god that controlled the life and death of the warrior. The next stage in the life of an Omaha youth was marked by the rite introducing him to individual life and to the supernatural. Four days and nights the youth was to fast and pray, then in a trance he saw an object which was his personal connection with the universe, by which he could strengthen his spirit and his physical powers. There were societies the membership of which was made up of men who had had visions of the same object. The sequence of rites began at birth, with the announcement to all created things that a new life had come into their midst; when the child had acquired ability to move about of its own volition, its feet were set in the path of life, and it entered into membership of the tribe; the entrance into manhood required voluntary effort, and by prayer and fasting the man came into direct and personal relations with the supernatural.

Miss Fletcher states that "the tribal organisation was based on certain fundamental religious ideas, cosmic in significance." The real division of the tribe was based on the dual division in nature; each contained several "gentes," which in their turn were divided into "subgentes. . . . The Omaha gens was a group of exogamous kindred who practised a particular rite, the child's birthright to which descended solely through the father; and the symbol characteristic of that rite became the symbol, crest, or 'totem' of the gens." A noticeable feature in the book is the large number of prayers and songs, which are given in the native language, with a literal and free translation, and with the musical notation. A considerable space is given to an account of the social and secret societies; the

[1] Twenty-seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1905–6. Pp. 672. (Washington: Government Printing Office, 1911.)

latter dealt with mysteries, and membership was generally attained by virtue of a dream vision. The Omaha were a thoughtful and practical people. The idea of personality is dominant in the language and in the religious beliefs and practices. The force within this personality was recognised as that of the will, and "the Sacred Legend, which preserved the experiences of the years, emphasised the vital fact that better conditions are always attained by the exercise of thought, not by magical interferences." Enough has been said to show that Miss Fletcher has given us a monograph that deserves the careful study of all ethnologists, and will still further increase their indebtedness to the Bureau of American Ethnology.

A. C. Haddon.

THE ROYAL MICROSCOPICAL SOCIETY.

On Wednesday, October 16, a conversazione was held in the Great Hall of King's College, about four hundred fellows and guests being received by the president, Mr. H. G. Plimmer, F.R.S., and Mrs. Plimmer. The object in view was, so far as practicable, to gather together a series of exhibits which would indicate the many uses, both in science and commerce, to which the microscope is put at the present time. In addition, the conversazione afforded an opportunity for those engaged in microscopic work to show objects of interest or to demonstrate the use of apparatus or appliances for special purposes.

The centre of the hall was occupied with pond life exhibits, about forty microscopes having been arranged on the tables under the direction of D. J. Scourfield, and these were a centre of interest to a considerable number of observers throughout the evening. Other interesting exhibits were some very beautiful botanical slides showing mitosis, by H. F. Angus and E. J. Sheppard; a Siedentopf ultra-microscope and cardioid condenser system for the observation of ultra-microscopic particles, by J. E. Barnard; an Abbe diffraction microscope illuminated by means of a quartz mercury-vapour lamp, by J. E. Barnard and Powell Swift; an instantaneous reflex photomicrographic camera, by F. W. Watson Baker; some preparations exhibiting Brownian movement, by G. P. Bate; a complete optical bench and an apparatus for polishing metal surfaces, by Conrad Beck; an extensive series of saccharomycetes, by A. Chaston Chapman; a very interesting old microscope and accessory apparatus, by Prof. A. Dendy, F.R.S.; some diffraction experiments, by J. W. Gordon; a series of foraminifera, by E. Heron-Allen and A. Earland; microchemical reactions of a very striking character, by Prof. Herbert Jackson; an extremely beautiful series of photomicrographs in colour, by J. W. Ogilvy, and another series of stereo-photomicrographs of water mites, also in colour, by H. Taverner. The possibility of applying his micro-spectra camera to the production of photomicrographs in colour was demonstrated by J. Rheinberg, and this exhibit attracted a great deal of attention.

Prof. Minchin, F.R.S., exhibited a series of trypanosomes which were of great interest. In the adjoining theatre, three lectures were delivered during the evening, Dr. E. J. Spitta giving a kinematographic exhibition of pond life, Prof. Hewlett lecturing on insects as carriers of disease, and Mr. Max Poser showing a beautiful series of liquid crystals by means of a projection micropolariscope, each of the lectures attracting a large audience. Apart from the social advantages of such a gathering, the exhibits were in all cases of real scientific interest, and demonstrated that the Royal Microscopical Society may look forward to doing an even greater work in the future than it has done in the past in bringing before scientific workers the possibilities of the use of the microscope. That the instrument is now a necessity in nearly all branches of science is, of course, well known, but it is often used merely as a tool and not as an appliance which demands considerable skill in its use for the best results to be obtained. If the council of the society should decide that this conversazione is to be but the first of a series of annual gatherings to be held with a similar object, then the success which has attended this function may be regarded as an indication that its usefulness in the future may be considerably increased.

THE BRITISH ASSOCIATION AT DUNDEE.

SECTION M.

AGRICULTURE.

From the Opening Address by T. H. Middleton, M.A., President of the Section.

Interest in the practice of improved husbandry was first aroused in England by the books of Fitzherbert. The extent to which this author stimulated agriculture may be inferred from the appreciation with which his works were received in his own day, and copied by others for a century. He himself does not appear to have been acquainted with the classical writers. He describes the English practice with which he was familiar; he quotes frequently from the Scriptures and refers to early religious works, but only in writing of animal diseases, when he cites the "Sayinge of the Frenche man," is there any indication that he was influenced by foreign authors. Fitzherbert's "Boke of Husbandry" and "Surueyenge," while they are free from the direct influence of Roman writers, show us, nevertheless, that the English agriculture of his day owed much to Roman traditions. The careful business methods and accounting of the farm bailiffs of the Middle Ages, with which Thorold Rogers has acquainted us, were the methods which Fitzherbert learned and counselled, as they were the methods which Columella taught.

It was between 1523, when Fitzherbert's "Boke of Husbandry" was first printed, and 1557, when Tusser published his "Points of Good Husbandry," that the classical writers began to exert a direct influence on English farming. In 1532 there appeared Xenophon's "Treatise of Householde," "ryht counnyngly translated out of the Greke tonge into Englyshe by Gentian Hervet," which at once became popular and ran through a number of editions. At least as early as 1542 editions of the works on agriculture and gardening of Cato, Varro, Columella, and Palladius[1] were published in England, and they must certainly have been known to Tusser, for in his "Five Hundred Points of Good Husbandry," composed some years later, there is clear evidence of the influence of the writings of Xenophon and Columella. From the latter author Tusser adopts the method of a calendar, and he appears now and again to adapt Roman maxims to modern conditions. Thus in his calendar Columella says of March that it "is the proper time to cleanse meadows, and to defend and secure them from cattle; in warm and dry places indeed that ought to be done even from the month of January," and Tusser in his calendar for March rhymes:—

> "Spare meadow at Gregorie Marshes at Pask
> for feare of drie Sommer no longer time ask
> Then hedge them and ditch them, bestow thereon pence,
> corne, meadow, and pasture aske alway good fence."

It might be, of course, that in discussing the same subject, a subject moreover which does not admit of much difference of opinion, the similarity of the above-

[1] A translation of Palladius into English was made about 1420, but it was not discovered and published until within recent times.

quoted passages is accidental; but many of Tusser's rhymes so closely follow Xenophon's "Householde" and Columella's Eleventh Book that I am satisfied Tusser was familiar with both these ancient writers. Here, for example, from Tusser, is the charge concerning sick servants which Ischomachus gives to his young wife:—

> "To Seruant in Sicknesse see nothing ye grutch,
> a thing of a trifle shell comfort him mutch."

And here is a maxim for the housewife that Columella enforces:—

> "The woman the name of a huswife doth win
> by keeping hir house and of dooings therein
> And she that with husband will quietly dwell
> must thinke on this lesson and follow it well."

Until the dawn of the twentieth century no mere man would have been found to question the conclusion come to in the above verse; nevertheless, the emphasis on the "quietly dwell" indicates that in this particular case the inspiration is derived from Columella rather than from Xenophon. For while the woman described by the Greek writer is likened to the queen bee, by the Roman there is much lamentation because of the emergence of the "butterfly." Columella refers to the diligent dames of ancient Rome who lived at home and studied to improve their husbands' estates, and contrasts them with their successors in the first century, who had become indolent, refused to make their own clothes, and spent their husbands' incomes on dress. He then remarks, "Is it a wonder that these same ladies think themselves mightily burdened with the care of rural affairs, and esteem it a most sordid business to stay a few days in their country houses?"

It was, then, the practice of husbandry that engaged the English agriculturist's attention from the time of Walter de Henley to Thomas Tusser, and the purpose of my digression into domestic subjects is to show that when the ancient writers were rediscovered in the middle of the sixteenth century, it was not the frequent references of Xenophon to the science of husbandry but his economic and moral teaching: not Columella's First Book, with its appeal for doctors and disciples who might apply themselves to the study of agriculture, but his Eleventh Book, with its calendar of operations and its directions for the ordering of the bailiff and the bailiff's wife, that attracted Tusser and his readers.

The awakening of interest in husbandry was largely due to the rapid changes in the economic conditions of England which set in about Fitzherbert's time.

The change in the cost of living directed men's attention to the husbandry and housewifery recommended by Fitzherbert and Tusser. The smaller landowners, who could no longer afford to live on their rents, and who saw that yeomen and tenant farmers were prospering, turned their attention to farming, and agriculture became an important occupation of the educated classes.

The yeoman and tenant farmer did not ask for textbooks on agriculture, but the new agriculturists required information, and thus there arose at the end of the sixteenth century a great demand for books. The booksellers were not slow to make provision for the demand, writers were secured, books were published, and of the more popular many editions were sold.

Sir Richard Weston, a Surrey landowner, who succeeded to his estates in 1613 and who had travelled in Brabant and Flanders, was the first English agriculturist to introduce practices approved on the Continent. He grew turnips for feeding cows, a century before the time of Turnip Townshend; nearly three hundred years ago he was experimenting, as we are still doing, with clover seed grown in different countries; he had thirty to forty acres of clover sown with barley, and he was inveighing against the sophistication of "outlandish" grass seeds and contriving plans for raising pure stocks at home in the approved fashion of to-day.

It was not only from Brabant and Flanders that travellers brought to England information about foreign agriculture. As one result of the development of commerce voyagers were introducing from distant countries such important plants as the potato and tobacco, and were exciting interest by their stories of foreign products. A desire to make experiments with these novelties was but natural, and experimental farming received a powerful impetus from the teachings of Francis Bacon, the first exponent of the inductive method. Having, as he wrote, "taken all knowledge to be my province," Bacon was himself an amateur farmer, and if he was not a successful one he was at least intent upon introducing methods of "industrious observation and grounded conclusions." It is to Bacon, I think, that Arthur Young alludes in a passage in which he describes a Lord Chancellor of England as having procured and read every published work on husbandry so that he might learn how to farm, and who, having met with ill-success, collected the offending books and lighted a bonfire! But let us not think lightly of the efforts of this distinguished amateur farmer. The agricultural writers of the succeeding century, indeed, refer to the influence of Bacon in terms that suggest for agricultural science the origin of the phœnix. We may, at least, agree that about the time of Bacon's bonfire this subject first began to attract the notice of scholars.

In spite of the political troubles of the second quarter of the seventeenth century, agriculture continued to secure increased attention, for England had learned that in war or peace the food-supply must be cared for, and the importance of corn-growing increased with the rise in prices. Thus when the Commonwealth was established everything favoured a forward movement. At peace and able to return to country pursuits, the combatants, Cavaliers and Roundheads alike, became active improvers. Engineer agriculturists, like Vermuyden, carried out great drainage-works. Many estates had changed hands, and the new owners, not a few of whom, as Harte remarks, "had risen from the plough," were glad to return to it; others were amateur farmers intent on learning. The books of the old and trusted writers, Fitzherbert and Tusser, had been followed by the works of such authors as Norden, Markham, Plattes, and Hartlib. Bacon's teaching emphasised the need for further study and experiment. Behind the political and economic changes were the powerful, moral influences of the Puritan movement; it was at this time and under these conditions that the spirit of the improver, which had animated Columella, appeared among English agriculturists

The first practical farmer to plead the cause of the improvement of agriculture was Walter Blith, one of Cromwell's soldiers, who is supposed to have been a Yorkshire landowner, but who for some years, at least, was stationed in Ireland. Blith was an ardent agriculturist, who prefaced his practical book, "The English Improver Improved," by seven epistles designed to attract the attention of all classes of his fellow-countrymen to agriculture. It is in the epistle to the "Honourable Society of the Houses of the Court and Universities" that chief interest lies for us, for here we find an appeal for the systematic study of agriculture in words that recall the classical writers. Blith showed that agriculture required the close study of the learned, and that the societies (*i.e.*, the Colleges) of the Universities might if they wished do much for its advancement. He adds, "You that have the Theorick, may easiest discover the Mysteries of the Practick, and from you have I found most encouragement to this work, and seen most experiences of good husbandry than from any, and from you too I expect and waite for more discoveries of some thing I scarce know what to name it, which lies yet in obscurity, but I will call it the Improvement of the Improver."

Were we not now concerned with the spirit rather than with the form of the improvement, an interesting parallel might be drawn between the topics which Blith considers of greatest importance and those which to-day are engaging attention. In his epistle to the society, for example, there is an appeal to the learned to give their attention to applied science. Discussing the progress of the Dutch, Blith deplores that policy which Englishmen afterwards termed *laisser faire*. He says: "Our niceness in not nursing the fruits of our own bowells hath given them the opportunity to Improve our native commodities to the advance of their Manufacturidge to our shame, their praise"; then addressing members of the universities he adds, "I speak to wise men whom I would have more publique men. . . . Let me entreat you for the Peoples and your own posterity sake . . . put your shoulders to the work, greater things remaine and larger Improvements are yet to be discovered."

The earnest advocacy of Blith, the essays of "my good friend Mr. Samuell Hartleps," and the energy of landowners like Sir Richard Weston, led to a demand for the records of experiments, and in 1659 there was issued the first series of abstracts of agricultural experiments with which I am acquainted, under the title "Adam out of Eden." The experiments recorded by the author, Ad. Speed, are of considerable interest; but I mention him for another reason. He appears to have made a living by propounding improvements of an imaginary character. He wrote tracts for noblemen and others, containing estimates of the profits to be gained by adopting new methods. Blith scathingly refers to him as "Mr. Speed that superlative Improver," and remarks that so long as his books were private "I could bear it, and suffer wiser than myself to bee fooled because I was not wise enough as to beware of him, but now that they come to be sold in the Stationers' Shops, and spread about the country, to deceive, and beguile the Nation, I cannot forbear." This was written in 1652; as my edition of "Adam out of Eden" is dated 1659, it is clear that the nation continued to be "beguiled" for a considerable period by this particular Adam, the forerunner of a numerous family. Whenever there is a revival of interest in agriculture he flourishes; the new manure, the ravaging insect, the blighting fungus, all serve to bring "Adam out of Eden," and so long as an interested and gullible public exists, "that superlative Improver Mr. Speed" will be found among us. The pamphlet and the stationers' shop have become antiquated; the Adam of to-day has other methods, which I will not venture to particularise. After all, it is a healthy sign. It is only when the public thirst is deep that Adam gets his chance, and, like Blith, we must resign ourselves now and again to "bee fooled," for is it not one of the methods by which the improver is improved?

Walter Blith's appeal for the assistance of the learned did not long remain unanswered. At the time his "English Improver Improved" was published a society of scientific men had already been formed in London, and ten years later this society first received the name Royal Society, at the suggestion of John Evelyn. On October 15, 1662, Evelyn's "Discourse on Forest Trees" was presented to the society. Five years later, when the "Sylva" was published, the author in the preface tells us that the Royal Society was then doing much for husbandry.

John Evelyn was one of the prominent members of the Royal Society, and he seems to have taken a leading part in defending it against the attacks to which, in the first years of its existence, it was subjected. With much satisfaction he points out, in dedicating the second edition of the "Sylva" to King Charles II., that his essay and the work of the Royal Society have in the past eight years resulted in the planting of more than two million timber trees, and he adds that he has preserved the testimonials he has received with the more care "*because they are* Testimonials *from so many* honourable *Persons, of the* Benefit *they have receiv'd from the* Endeavours *of the* Royal Society, *which now adayes passes through so many* Censures."

With the exception of the "Societies of Learning and Gallantry" of the "Houses of Court and Universities" addressed by Blith, the Royal Society is the earliest to which any influence on agriculture may be traced, and it is certainly the first society which definitely included the improvement of agriculture as coming within its scope. It appears to have depended in no small degree for its early successes on the public interest aroused by the writings of Evelyn and Houghton, and there is evidence that the society gave much attention to agriculture during the second half of the seventeenth century, and that its patronage was much valued.

Evelyn's "Pomona," in which he discourses of fruit trees and cider, gives an interesting glimpse of some of the early activities of the Royal Society, for the work itself is based chiefly on contributions by members of the society to its "*well furnish'd Registers, and* Cimelia." Evelyn is careful to point out that these contributions were original papers, and that it was not the design of the society to "accumulate repetitions where they can be avoided." These new observations being in the society's esteem "*and according to my Lord* Bacon's" preferable even when "*rude and imperfect* draughts" than commonplaces "*adorn'd with more* pomp." Evelyn himself was not practically acquainted with cider-making, and his own interest in the subject, like that of the majority of his fellow-members, was Baconian—*i.e.* it consisted in a search for "grounded conclusions and profitable inventions and discoveries."

In other ways the members of the Royal Society encouraged one another in making improvements; thus when in 1666 Evelyn's "worthy friend" Mr. Hake went on a journey, he returned carrying with him—for eight hundred miles—some grafts for Evelyn, together with a "taste of the most superlative perry the world certainly produces." It was by means such as these, and by a policy which approved "plainness and usefulness" rather than "niceness and curiosity," that the newly-formed Royal Society commended itself to the country.

It is indeed probable that agricultural questions occupied much more of the attention of the Royal Society in the earlier years of its existence than the printed records suggest; we are told, for example, by the Scottish improver, "A Lover of his Country," that one of its most illustrious members, Sir Robert Boyle, was an enthusiastic agriculturist; he says: "I had the Honour to be known to that excellent Person and oft in his Company. He was the greatest Lover of Agriculture I ever knew, and I wonder he never wrote of it. I heard him say, it was a Pity there was not Seminaries of that, the most useful, and except Pasturage, the most ancient of all Sciences."

Not only were agriculturists attracted by the practical investigations of the Royal Society, but impressed by the value of its methods and organisation, and Worlidge suggests that nothing would more conduce to improving agriculture than the constitution of subordinate provincial societies "*whose* *principal care and office might be to collect all such Observations, Experiments, and Improvements they find within their Province . . . which of necessity must abundantly improve* Science *and* Art *and advance* Agriculture *and the* Manufactures."

The proposal made by Worlidge was unheeded at the time, for not until nearly a century after his suggestion was made did English agricultural societies begin to appear. A retrograde movement set in soon after the Restoration, and although the Government sought to foster improvements and passed several Acts with the object of stimulating farming, Harte tells us that a "total change of things, as well as the very cast and manner of thinking, joined with immoral dissipation, and a false aversion to what had been the object and care of mean despised persons, soon brought the culture of the earth into disrepute with the nobility and gentry."

An insight into the conditions of the last quarter of the seventeenth century and the first quarter of the eighteenth is given us by Lisle, who wrote the introduction to his "Observations on Husbandry" in 1713. He begins by remarking that it is one of the misfortunes of the age that it lacks honourable conceptions of a country life; he directs attention to the fact that in the decadent days of Rome luxury increased and husbandry was neglected. He calls on the landowner to look round him and see how many fine estates are daily mortgaged or sold, "and how many antient and noble families destroyed by the pernicious and almost epidemic turn to idleness and extravagance." He discusses at length the advantages of an agricultural career, and recommends it as a profession for the eldest sons of gentlemen, who might regard it as "a school of profit and education; whereas," he continues, "it is rather looked on as a purgatory for the disobedient, a scene of punishment, to which a son, who answers not his father's expectations, is to be abandoned; or a condition of life of which none would make choice, but such whom fortune has not in other respects favoured. If the country gentlemen therefore frequently consist of persons who are either rusticated by their parents in anger, or who, making a virtue of necessity, settle on their estates with aversion or indifference, it is no wonder the comedians exhibit them on our stage in so despicable and ridiculous a figure; but this is the fault of the persons and not of the art. Were they properly initiated in the study of Agriculture, and pursued it as they ought, it would be so far from excluding them from useful knowledge, and bringing them into contempt, that I may venture to assert they would find it the best school of education, and the fittest to prepare them for the service of their country in the two houses of parliament of Great Britain."

Such were the dispiriting social conditions with which the successors of Evelyn in the Royal Society had to contend. The agricultural experiments of the society therefore attracted but little attention outside the ranks of the curious. Houghton, a contemporary of Evelyn's, started a periodical publication, *Houghton's Letters*, but it soon ceased. A generation later, and about the period to which Lisle refers in the above quotation, a work on husbandry was written by a fellow, John Mortimer. It is dedicated to the society, "to whose encouragement, inquiries, and direction it owes its birth." Special thanks are given to another fellow, Dr. Sloane, who assisted the author, and "has greatly contributed to the advancement of useful knowledge."

Testimony to the activity of the Royal Society at this period is also to be found in a work on "Curiosities of Nature and Art in Agriculture and Gardening," a translation from the French of the Abbot de Vallemont by Bishop William Fleetwood, published anonymously in 1707; this work contains the passage: "The Royal Society of *England* who are so zealous for the Perfection of Agriculture and Gardening, have apply'd themselves with great Care to find out the true way to make Salt-petre, which they likewise allow to be the chief Promoter of the Vegetation of Plants."

About this time botanical questions of much interest to agriculturists were occupying the attention of the Royal Society. Robert Ball and Samuel Moreland were investigating reproduction in plants, and a few years later Richard Bradley, another fellow, professor of botany at Cambridge, but more of an agriculturist than a botanist, was explaining how, by cross-breeding, "such rare kinds of plants as have not yet been heard of" may be produced. He refers specifically to a cross between a carnation and a sweet-william, but by inference to Burgoyne's Fife and the other things "not yet heard of" that are associated with agriculture and botany in the Cambridge of to-day.

Various causes, among which the influence of fellows of the Royal Society must be given an important place, led the landowners and the educated classes of England again to turn their attention to agriculture about the beginning of George II.'s reign. The revival was associated with and followed, as it has in recent time, a development in gardening. William and Mary were patrons of horticulture, they greatly improved the Royal gardens, and the nobility, in imitation, laid out parks and *parterres*.

A writer on agriculture and gardening of this period, the Rev. John Laurence, of Bishop Weremouth, Durham, attributes the revival, not merely to progress in the art of gardening, fostered by nobles and statesmen, but to the Royal Society—of which he says that its Philosophical Transactions "are standing Memoirs of the Zeal and Activity of many Persons of Quality and Learning," whose "Discourses and Experiments" have "advanced much Light in the Art of Husbandry."

Although for seventy years after its formation, and throughout a period during which agriculture was neglected by the landed classes, the Royal Society did much to keep alive the spirit of the improver, the unfortunate apathy of the agriculturist prevented that progress which appeared to be imminent when John Evelyn wrote his "Pomona." It was not possible for a learned society in London to investigate agricultural questions in the absence of the scientific agriculturist himself; subjects of agricultural interest were therefore discussed chiefly from a theoretical point of view, and, neglecting the teachings of Bacon and the example of Evelyn, there arose that use of the deductive method which in the past two centuries has done so much to hinder the progress of agricultural science.

The first to show up the fallacy of the deductive method in studying this subject was Jethro Tull, who, though he himself fell into the errors which he condemned, was, in his understanding of the true relationships of science and practice, far ahead of any of his contemporaries. A lawyer by training, he probably took to agriculture because of his poor health. He worked at it for twenty years before he was induced to set out his views in writing, and it was years after he began farming before he read anything on the subject. Dissatisfied with the practice of his times, he set himself to reason out new methods and to make experiments. He got suggestions from foreign travel; he tells us, for example, that the first hint of the value of horse-hoeing husbandry was derived from the ploughed vineyards of France; but he was careful to submit his ideas to the test of experiment before he adopted them in farm practice. His temper, which, if one may judge from his references to his labourers, was far from serene, was much tried by his controversies with *Equivocus*, and his criticisms of the writers and scientific men of the preceding half-century are severe. He remarks, for example, on the superficial knowledge of agriculture shown by "Mr. Laurence, a divine; Mr. Bradley, an academic; Dr. Woodward, a Physician; Mr. Houghton, an Apothecary; these for want of practice could not have the true theory; and the writers who are acquainted with the common practice, as Mr. Mortimer (whether for want of leisure, or not being qualified, I do not know) have said very little of any theory." He freely criticised the writings even of "Mr. Boyle" and of that "miracle of a man Sir Isaac Newton," and in a characteristic sentence he remarks: "From Sir Isaac's transmutation arguments we may learn that a man never ought to depend entirely upon his own for support of his own hypothesis." An admirable sentiment which I am afraid that Tull himself, and many another agriculturist since his time, failed to lay to heart.

Jethro Tull's great work was published two generations after Walter Blith first endeavoured to awaken the spirit of the improver in English farmers. Throughout this period not much progress had been made, but a change was at hand. When in 1730 Turnip Townshend left politics and went down to Norfolk to farm his estate, the tide had turned, and henceforward throughout the eighteenth century there was a rapid improvement in the practice of English agriculture. Of these developments no small share may be attributed to the influence exercised by the Royal Society during the first seventy years of its existence.

The agriculture of Scotland had not shared in the revival due to the work and writings of the English improvers, and was in a very backward state in the middle of the seventeenth century. Its condition is indicated by John Ray, who, in 1661, some months before the Royal Society received its charter, set out from Cambridge to spend the Long Vacation in a Scottish tour. He crossed the Tweed on August 16, and proceeded from Berwick, via Dunbar, to Edinburgh. His first day's journal gives us his impressions of what is now, and probably was then, one of the foremost agricultural districts in Scotland. "The ground in the valleys and plains bears good corn," he says, but "the people seem to be very lazy, at least the men." Scottish women, he writes, "are not very cleanly in their houses, and but sluttish in dressing their meat." "They have neither good bread, cheese, or drink. They cannot make them, nor will they learn. Their butter is indifferent, and one would wonder how they contrive to make it so bad."

After the Union Scotchmen in increasing numbers took the high road to London, and at first with much less profit to themselves than those acquainted with the Scot in modern times might suppose. As a result of social intercourse, the upper classes began to copy the manners and customs of their rich English neighbours, and prices and the cost of living rose rapidly. These economic changes, as in England a century before, turned the attention of landowners to the improvement of their estates; but as the Scottish laird of the beginning of the eighteenth century did not take readily to farming, a few of the more enlightened men among them saw that if improvements were to be made special measures were necessary. Impressed by the usefulness of the Royal Society, these reformers conceived the idea of establishing an Agricultural Society in Scotland. This society, which met for the first time in Edinburgh on June 8, 1723, and adopted the name of "The Honourable the Society of Improvers in the Knowledge of Agriculture in Scotland," was the first association to be formed for the express purpose of promoting agriculture. Some account of its work is given in its Transactions, published twenty years later, but for a contemporary view of the problems which engaged the society's attention we must go to a book published in Edinburgh in 1729, under the title of "An Essay on Ways and Means for Inclosing, Fallowing, Planting, &c., Scotland, and that in Sixteen Years at farthest, by a Lover of his Country."

Of all old books on agriculture this is, to me, the most interesting. The anonymous writer is believed to have been Brigadier-General Mackintosh of Borlum, one of the rebel leaders of 1715, who fell into the hands of the English at Preston, was imprisoned in Newgate, and sentenced to death. But this Highlander was not to be held by English gaolers. With some of his comrades he overpowered the prison guard and made good his escape; recaptured in 1719, he spent the rest of his life in prison. The essay was written, its author informs us, in "my Hermitage"—a cell in Edinburgh Castle—and the writer remarks that he can give no better reason for his work "*than other* Enthusiasts *do, the Spirit* moves me."

The prisoner employed his enforced leisure to great advantage. He displays more familiarity with the classical authors than any of his predecessors, or for that matter than any of his successors, except Harte and Adam Dickson, and he had obviously studied all the more important works published in England in the previous century. He argues that since the Union, Scotland had not made progress, and that, while extravagance had spread and necessaries greatly increased in cost, no attempt had been made to learn good rural economy from the English. He points out that until they improve their estates Scottish lairds cannot hope to emulate English landowners. He counsels fallowing and inclosing, and recommends that skilled English labourers should be brought to teach English methods. He indicates where the best workmen might be obtained. Men from Devonshire for denshiring (paring and burning); men from Cambridgeshire for draining; men from Hertfordshire for ploughing; from Hereford for fruit planting; and from Shropshire for hedging. He estimates that six hundred and forty men would be required for Scotland. A "regimental number," he facetiously remarks, but a welcome regiment, for they would be armed only with spade and shovel! He would apportion a group of these men to every county in Scotland and place them under the guidance of county supervisors. "And if I might have my wish," he says, "we should not go on by Halfs, and all *Europe* should be quickly disabused of the Reproach they load us with of *Idleness* and *Poverty*." In another passage he prophesies that "*Scotland* from one of the poorest, ugliest, and most barren Countries of *Europe*, is, in a very few *Years*, become one of the richest, most beautiful and fertile Nations of it," and who would now assert that the old rebel's prophecy has not been fulfilled?

As already mentioned, the Society of Improvers was constituted at a meeting held on June 8, 1723. A council of twenty-five members was elected, the council was divided up into subcommittees, each of which was charged with the care of a special branch of agriculture; the rules set out that the members of committees were to "chuse different subjects in Agriculture and mark down their thoughts thereon in writing." They were also to correspond with the most intelligent agriculturists all over the country and to endeavour to get small local societies formed. The chief duty of each subcommittee was, however, to give advice on the means of carrying out improvements. Members were asked to send in an exact statement of their difficulties, and answers were forwarded by the society. If the suggestions proved useful, the recipient of advice was expected to report the result for the benefit of his fellow-members.

The volume of "Select Transactions," published in 1743, contains a number of specimens of the questions sent in and the answers supplied. Such subjects as the draining of boggy land, the use of marl and lime, the effects of seaweed as manure, the cultivation of potatoes, hops, sainfoin, and flax; the feeding of cattle and the employment of steeps for corn were dealt with. Most of the correspondence is with Scotchmen, but occasionally letters from others occur, including an interesting communication from Jethro Tull in which he says that "twenty years ago there was much the same way of tillage in England as is now in Scotland, but it has since been exploded by experience, and the farmers have enriched both the land and themselves by plowing it more than they were wont." Directions for lime-burning are contributed by Mr. Lummis, "who came from England and made the Rotheran Plough." The Transactions have an advertisement of this plough, from which it appears that the Earl of Stair had sent one of his men to be taught by "the best Plough and Wheel-Carriage wrights in England," and that Rotheran ploughs of very superior workmanship were being made at Newliston, West Lothian. The Earl of Stair further laid agriculturists under obligation by introducing turnips, cabbages, and carrots as field crops, and he bred very good Galloway cattle. Another notable man among these early improvers was the Earl of Islay, who gave special attention to the cultivation of peaty soils and succeeded in producing good corn and grass on land previously thought to be of little value. He also planted extensively, and, according to Maxwell, introduced the larch, among other trees, to Scottish foresters.

The society did not confine its attention exclusively to agriculture. It noted a natural connection between the agricultural and fishing industries, and did much to promote the latter, thus establishing an early precedent for the association of agriculture with fisheries for administrative purposes. Manufacturers, too, were encouraged, and in this connection there stands out the name of the Duke of Hamilton, who moved the following "Overture": "That all of you and all under your Influence, should, for Examples to others, buy no foreign Linen for Shirting, Bed-linen, or any other Household-furniture; and that you should propagate to the utmost of your power the wearing of home-made stamped Linen." The consequence, we are informed, was that "even at Publick Assemblies of Persons of the greatest Distinction, the whole Company appeared dressed in Linen of our own Manufacture." The Duke's success with linen led him next to propose a resolution against the drinking of foreign spirits, so that the great sum annually sent to France for brandy might be kept at home! The consequences were not so immediately noticeable as in the case of linen, for the local records of the east of Scotland show that the smuggling of French brandy was a very profitable trade throughout the eighteenth century. It is, however, the case that at a later date the Duke's advice was followed, for not only linen but liquor of native manufacture came to be appreciated, "even at Publick Assemblies of persons of the greatest Distinction"; at assemblies, moreover, on both sides of the Tweed!

During the twenty-two years of its existence the Honourable Society of Improvers became a powerful and important body. Its influence, it should be noted, was obtained by educational methods, for its funds were small, it had no State subsidy, as had the Irish Society, it offered no premiums, but it drew together in the cause of agricultural improvement many of the most prominent Scotchmen of the period, and it undoubtedly laid the foundations of that successful agriculture for which Scotland has ever since been noted. In 1743 the society had 299 members, and an examination of the list reveals many well-known names representing all sections of the educated classes of Scotland, with the notable exception of the clergy.

Of all the members, those who best deserve our notice are Thomas Hope of Rankeilor, president, and Robert Maxwell of Arkland, editor of the Transactions. Mackintosh refers to Hope as a man who had taught improved agriculture to hundreds of his fellow-countrymen. He studied the subject, not only in England, but in France, Flanders, Holland, and other Continental countries, and Maxwell says of him "that it has been much owing to *Mr. Hope of Rankeilor* your Preses, that this Society was entered into and that the Spirit of it rose so high," and adds that he "has been instructing others in the Knowledge of it and been preaching up the publick and private Advantages arising from it for a continued Tract of more than Twenty Years' Time." Of the spirit which animated Robert Maxwell himself we have ample evidence in the dedication of the "Select Transactions." Reviewing what has been done by the society and considering that which might still be done, Maxwell writes, "since the Case stands thus, how much doth it concern the Publick and every Individual that Agriculture be encouraged and that the *Knowledge* of it, the efficient Cause of all those inestimable Benefits, should be taught to all who are willing to learn the Principles of this the most useful of all Sciences; to all who desire to know the secret Causes why some plants enrich, and others impoverish the Ground in which they grow; why different Methods of Husbandry produce different Effects; and in general to all who incline to study the Reasons for and against, the different Methods practised? They that do not study Agriculture as a Science do right only by chance, and that rarely happens. Why then should Reason be so little exercised, as generally it is, in this Matter of the greatest Importance?" He then refers to the opinions of Virgil, and to the views expressed by Columella on the subject of teaching agriculture, and he urges the society to take steps to found a professorship.

Maxwell proposed that the society should address a memorial to the King on the subject of a professorship. "You are," he wrote, "a great Body of loyal Subjects and generally of great Distinction, and I humbly think upon a proper Application to his Majesty, you could not fail to have sufficient Influence to get such a Professor or Inspector named or both."

But, alas! neither professor nor inspector did Maxwell see, for within two years Prince Charles Edward had landed in Scotland, the Marquis of Tullibardine was rallying the Highlanders to the Stuart flag, and the loyalty of the Honourable Society was subjected to a strain which it could not withstand. Most of the members took the advice of Duncan Forbes and held out for the King, but others, like the Duke of Perth and Lords Cromatie, Balmerino, and Lovat, followed Prince Charlie. When peace was restored, the Honourable Society, and not a few of its members, had ceased to exist; but the purpose for which it was founded had been achieved, and the spirit of the improver lived on.

One of the objects of the Honourable Society of Improvers was to develop local societies. Two of these may be traced in Scotland before 1745, one in

Buchan, the other in East Lothian. The former appears to have been started about 1730 by James Ferguson of Pitfour among his Buchan tenantry. Ferguson was a friend of Thomas Hope's and believed in his methods of "preaching improvements." He supplied the members of the Buchan Society with books, and he himself attended their meetings. In 1735 this society published a small volume which had been drawn up by the members at their meetings, entitled "A True Method of Treating Light Hazely Ground; or, an Exact Relation of the Practice of Farmers in Buchan containing Rules for Infields, Outfields, Haughs, and Laighs." In many respects this is a remarkable little work. It relates exclusively to local farming, and while the inspiration may have come from Edinburgh, the book itself bears no evidence of outside influence. Their independence is indeed a noteworthy characteristic of the members of this Buchan Society. From certain references which appear in their Proceedings it may be surmised that they were well acquainted with agricultural writers. But instead of recounting the opinions of others, and speculating as to their value for Buchan, this society of tenant-farmers adopted the true scientific method, they described their practices in detail, discussed them fully, and, being satisfied that they were applicable to local conditions, they reduced their methods to rules. In matters too deep for them, their philosophy rested on a firm basis. Here, for example, is an explanation of the early fruiting of wild oats. This pestilent weed they urge all farmers to destroy by "cropping the wild oats how soon they come out of the hose, who appear always about eight days before the tame. Thus is Providence so kind as to tack that to their nature which is the means of their own destruction."

The second of the local Scottish societies, existing before 1745, was that established by an enlightened landowner, John Cockburn of Ormistown, in East Lothian. Robertson, in his "Rural Recollections," gives July 18, 1736, as the date of its formation. With Cockburn were associated Sir John Dalrymple and other country gentlemen. From a reference made to their meetings by Henry Home, it would appear that in this society we have the origin of the "farmers' dinner." Home counsels landlords to "convene" tenants once a year to a "hearty meal," at which they were to be instructed in new methods of husbandry. "It was by such means," he adds, "that the late John Cockburn of Ormistown promoted emulation and industry among his people." But Cockburn did not confine himself to an annual dinner. Monthly meetings were held for the discussion of agricultural improvements, and these were much appreciated not only by Cockburn's tenants, but by neighbouring landowners like the Earl of Stair and the Duke of Perth, who attended regularly. Even the '45 did not suppress these monthly meetings, and after Preston Pans the Duke of Perth was mindful enough of Ormistown to send troops to protect the members, so that they might quietly continue their criticisms of Tull and their appreciations of turnips.

Maxwell tells us that the Dublin Society (established 1731) was formed in imitation of the Society of Improvers. It is clear when Arthur Young wrote that to the Dublin Society "belongs the undisputed merit of being the father of all similar societies now existing in Europe" he meant that it was the oldest of existing agricultural societies, and not the first society of its kind. The Dublin Society soon after its formation received a Government grant and could therefore spend much more on its work than its Scottish prototype. Time will not permit of a reference to the work of this society, but mention may be made of the experimental farm established by the unfortunate John Wynn Baker, under its auspices. The farm was started in 1764 and continued until about 1770. Schemes were drawn up by Baker in consultation with the society, and an annual grant of 200*l.* was made in support of the experiments; two volumes giving the results were issued.

In 1754 the Royal Society of Arts was established, and almost immediately afterwards it began to give attention to agriculture. A record of its valuable work written by Sir Henry Truman Wood has recently been published in the society's Journal.

The same year that saw the formation of the Royal Society of Arts brought together in Edinburgh a small group of distinguished men who formed themselves into the Select Society. The purposes were the discussion of philosophical questions and practice in public speaking. The idea came from Allan Ramsay, an artist and son of the poet. Alexander Wedderburn was elected chairman (as Lord Loughborough, the first Scottish Lord Chancellor of England, he affixed the seal that gave Sir John Sinclair his Board of Agriculture), and among the members were Adam Smith, David Hume, Henry Home (later Lord Kames), and William Robertson (afterwards Principal of Edinburgh University). This society soon attracted all Edinburgh residents who were in any way distinguished. But in one respect it was a failure; certain members, we are informed, always talked, and the wisdom of others was in danger of being suppressed and unavailing. It is said, for example, that Adam Smith and David Hume never opened their lips! It appears, therefore, to have been decided that the society's genius should be turned to practical objects, and within the Select Society a new organisation, the Edinburgh Society, was formed in 1755, "for the encouragement of Arts, Sciences, Manufactures and Agriculture"—*i.e.* for the same purposes as the Society of Arts had been established in London a few months earlier.

An account of the Edinburgh Society is given by Ramsay in his "History of the Highland and Agricultural Society of Scotland," from which it appears that the methods of this society—the offering of premiums for live-stock and implements—were those which have since been everywhere adopted. In 1759, for example, we read that at the show of horses nine stallions were exhibited, "all very good." But the goodness of the stallions and of the objects did not bring prosperity to the Edinburgh Society; talent was more abundant than money in Edinburgh in the middle of the eighteenth century, subscriptions remained unpaid, the premium list had to be reduced, and finally the Select and the Edinburgh Societies disappeared together in 1765.

Before concluding these notes on early associations let me ask your attention very briefly to some of the evidences of their influence on the agriculture of a later period.

The chief aims of the early societies were to impress upon landowners in the first place the interest afforded by the study of agriculture and in the second the duty of providing an increased supply of food for the nation. Nothing is more marked in the writings of such improvers as Blith, Worlidge, Lisle, Laurence, and Mackintosh than their insistence on the importance of agriculture as a subject of study. Until the educated among their fellow-countrymen could be interested in the principles of agriculture, it was clear to these far-seeing men that progress could not be made.

The change in the attitude of the educated classes to agriculture that took place within a century of the formation of the Royal Society is indicated in all the works published after 1750. Hirtzel, of Berne, *e.g.* in

"The Rural Socrates" (second edition, 1764) remarks: "It is no longer a controvertible point whether the science of Agriculture merits the distinguished attention of philosophical minds, and is the proper study of the most enlightened understanding; since the proof is beyond contradiction, that a judicious rural economy is one of the chief supports of the prosperity of a State." In Henry Home's dedication of "The Gentleman Farmer" to the president of the Royal Society (1776), we find this passage: "Agriculture justly claims to be the chief of arts, it enjoys beside the signal pre-eminence of combining deep philosophy with useful practice"; and in the preface to the same work he says: "Our gentlemen who live in the country have become active and industrious. They embellish their fields, improve their lands, and give bread to thousands." He contrasts these pursuits with those which formerly occupied the country gentleman: "His train of ideas was confined to dogs, horses, hares, foxes; not a rational idea entered the train, not a spark of patriotism, nothing done for the public."

How unlike the state of affairs described by Home were the conditions in a country resembling Britain, but in which the spirit of the improver had not been awakened, may be indicated by a quotation from a report on the farming of Holstein and Mecklenburg sent to Sir John Sinclair in 1794. The writer, M. Voght, states that the agriculture of North Germany was fifty years behind that of England, and explains its depressed state by saying: "Our noblemen are no farmers, and our farmers no gentlemen; our authors on agriculture possess no cultivated land, and those few who could give to the public the precious results of long experience and labour would starve their printer for want of readers."

The landowner of North Germany, towards the end of the eighteenth century, was, indeed, in very much the same state as the landowner of Britain in the first quarter; and it is when we compare the conditions described by Lisle, Mackintosh, Home, and Voght that we begin to appreciate how much British farming owes to such associations as the Royal Society of England and the Honourable Society of Improvers of Scotland. Had not the interest of landowners, and of the educated classes generally, been secured, there is no reason to suppose that the agriculture of Britain in 1794 would have been markedly in advance of that of Germany.

Both in England and Scotland the first impetus towards progress was economic in its character, and throughout the seventeenth and eighteenth centuries economic causes were constantly accelerating the improvement of agriculture; but we must not make the mistake of supposing that a rise in prices necessarily brings about improvements in husbandry. A motive for improvement is provided and more labour may be drawn to agriculture, but it does not follow that there will be a real advance, and that there will be more food produced for the use of workers in other industries. Without changes of system, *i.e.* without improvements based on new discoveries, the effect of a rise of prices in a self-supporting country would merely be to alter the proportion of the population engaged in agriculture, and to form congested districts. This was the danger that threatened England early in the seventeenth and Scotland early in the eighteenth centuries; but fortunately for each country an intellectual revival followed close on the rise in prices, and attention was directed not only to the necessity for more food, but to the need for improvements which would afford a surplus for the support of the industrial classes.

Within recent years the improvers of the eighteenth and early nineteenth centuries have been much criticised for their land policy, their enclosures, and their treatment of labourers; but one thing at least the agriculturists of 1760–1815 saw more clearly than their modern critics—they recognised that if their country was to become a great manufacturing nation, more food must be grown; and to this task they applied themselves so successfully that, as Porter points out, the land of Great Britain, which in 1760 supported about eight million inhabitants, in 1831 supported sixteen millions. When we reflect that the implements of husbandry were rude, that thorough drainage had not been introduced, that artificial manures (except crushed bones) were scarcely known, that oilcakes were scarce, that grain was too valuable to be given freely to cattle, that in bad seasons live-stock had to be starved so that men might be fed, that in good seasons prices fell rapidly, and with them farming profits, and that credit was difficult to obtain and interest high, those of us who know something about the ordinary work of the farmer can realise the strenuous efforts that must have been necessary to wring from land a sufficiency to feed this rapidly growing nation and to maintain it in health and comparative comfort. Even as late as 1836 Porter shows that it would have been impossible to feed any considerable part of the people on imported food. "To supply the United Kingdom with the single article of wheat," he says, "would call for the employment of more than twice the amount of shipping which now annually enters our ports."

Part of the additional food-supply was obtained by enclosing about seven million acres of land between 1760 and 1834; but as more than three times this area must already have been enclosed, as much of the land enclosed after 1760 was of poor quality, and as all of it had formerly contributed in some degree to the food-supply of the country, it is obvious that between 1760 and 1834 the rate of production per acre must have been largely increased.

Improvements in the art of agriculture cannot be rapidly introduced; there is first of all an experimental stage, and when improved methods have been learned they pass but slowly from district to district. Before any marked advance in the art can take place, there must therefore occur a period during which a foundation is being laid. It was about 1760 that our population began to increase rapidly, and it was then that agriculturists were called upon to produce more food. As we have seen, they were able to double the food-supply in seventy years. It cannot be doubted that this marvellous feat was rendered possible by the pioneer societies of the preceding century, or that it was the spirit of the improver, which the early associations had fostered, that animated the men from whom Arthur Young and Sir John Sinclair learned. If, in place of those enterprising agriculturists whose improvements are described in the reports of the first Board of Agriculture, our shires had been occupied by the dull-witted country gentlemen referred to by Lisle, or the "upstart sparks" condemned by Mackintosh, the history of this country must have been very different. Behind the military and naval victories which made Britain a great Power, was a commissariat supported by the agricultural classes. For the great industrial army which the genius of Arkwright, Watt, and other inventors provided with employment there was raised an ever-increasing food-supply. Political and industrial development alike depended on the rate of increase of the population, and this again on the rate at which the means of subsistence could be raised from British soil.

Although the economic position has undergone a revolution there is still work for the improver; no longer indeed do our industrial classes depend for subsistence on the surplus products of the British farmer, but after a long period of forgetfulness, once again it has been recognised that a progressive agriculture is essential to the well-being of the nation. This is not the time to discuss the nature of the questions which press upon us to-day; but let us not forget that they are our questions. To this newly-formed section of the British Association has descended the task of the early associations; it is the privilege of its members to preserve, and to hand down to their successors, that spirit of the improver which animated alike the ancient writers of Greece and Rome and the British societies of the seventeenth and eighteenth centuries; and to-day we may take to ourselves the exhortation of Walter Blith, for his words apply to Section M as they did to its predecessors, "from you, too, I expect and waite for more discoveries of some thing, I scarce know what to name it, which lies yet in obscurity, but I will call it the Improvement of the Improver."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The electors to the Isaac Newton studentships give notice that in accordance with the regulations an election to a studentship will be held in the Lent term, 1913. These studentships are for the encouragement of study and research in astronomy (especially gravitational astronomy, but including other branches of astronomy and astronomical physics) and physical optics. The persons eligible are members of the University who have been admitted to the degree of Bachelor of Arts and are under the age of twenty-five years on the first day of January, 1913. The studentship will be tenable for the term of three years from April 15, 1913. The emolument of the student will be 200*l.* per annum. Candidates for the studentship are invited to send in their applications to the Vice-Chancellor between January 16 and 26, 1913, together with testimonials and such other evidence as to their qualifications and their proposed course of study or research as they may think fit.

The Arnold Gerstenberg studentship has been awarded to A. E. Heath, of Trinity College. The Gedge prize has been awarded to A. V. Hill, of Trinity College, for his essay entitled "The heat production of amphibian muscle and of cold-blooded animals."

SOCIETIES AND ACADEMIES.

London.

Royal Society, August 23.—F. W. **Aston**: The influence of the nature of the kathode on the length of the Crookes dark space. (1) The relations between the values of pressure, voltage, current, and the length of the dark space are determined for plane kathodes of many different materials, and found to satisfy the same form of equations as those previously given for aluminium, the constants varying considerably. (2) Roughness of the kathode surface does not appear to affect the discharge, if the dimensions of the irregularities are small compared with the length of the dark space. (3) The length of the dark space is shown, in the cases examined, to be greatest for silver and least for magnesium, the metals following the same order as in the case of the kathode fall. (4) The rate of change of length of the dark space with change of current density at the surface of the kathode seems much the same for all kathodes. (5) Difficulties in the way of arriving at a satisfactory explanation of these and other data connected with the dark space are indicated and shortly discussed.—F. W. **Aston**: The discharge between concentric cylinders in gases at low pressures. (1) The relations between pressure, voltage, and the length of the Crookes dark space in the discharge between concentric cylinders take much the same form as those in the discharge between parallel planes. (2) Curvature of the surface of the kathode appears to have no influence upon the rate of alteration of the length of the dark space with change of current density, *so long as the latter is measured at the surface of the kathode.* (3) *Ceteris paribus*, the length of the dark space is greater for a convex cylindrical surface than a plane, and for a plane than a concave one.

Manchester.

Literary and Philosophical Society, October 1.—Prof. F. E. Weiss, president, in the chair.—Prof G. **Elliot Smith**, F.R.S.: Ancient stone monuments. There is, stated the author, no longer any room for doubt that the monuments known as "megalithic," which are to be found along the coast-lines of Europe, North Africa, and Asia, ranging from the Atlantic to the Pacific, embody the same general idea which has been elaborated in various ways amongst the different peoples. The repetition of apparently insignificant details in these monuments in countries as far apart as France and India, and Ireland and Japan, makes it quite certain that no theory of independent evolution of the idea of erecting these curious monuments can be entertained. All the evidence we possess tends to prove quite definitely and conclusively that the farther away from the eastern Mediterranean, whether east or west, north or south, the more recent the date of their construction. Thus, there can be no doubt that the idea of erecting such monuments originated somewhere in the region of the eastern Mediterranean. Now, so far as we know, the art of building in stone was cultivated in Lower Egypt at an earlier period than elsewhere. It is also known that every stage in the evolution of the burial customs associated with stone mausolea and every phase of the gradual development of the craft of stone-working have been preserved in Egypt. Further, in Egypt, the people were making a variety of stone tombs and mortuary chapels, which are obviously the prototypes of every kind of megalithic monument, long before any such monument is known to have been erected elsewhere. The conclusion is that the idea of building such monuments originated in Egypt.

Göttingen.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), parts 5 and 6 for 1912, contain the following memoirs communicated to the society:—

May 18.—P. **Hertz**: A proof by Boltzmann of the second law of thermodynamics.—W. **Voigt**: Electric and magnetic double-refraction (i.), with an appendix by P. Langevin. Th. **Brandes**: Plesiosaurus (Thaumatosaurus) aff. megocephalo Stutchbury from the lower Lias of Halberstadt.—W. **Blaschke**: Proof of the undeformability of closed convex inextensible surfaces. —K. **Försterling**: The theory of the Zeemann effect in any direction.—E. **Landau**: The number of integer-points in certain regions (*i.e.* the number of points with integral coordinates included within given regions of any number of dimensions).

July 20, 1912.—P. von **Liebermann** and G. **Révész**: Binaural combination of tones.—J. **Thomae**: The convergence of a Fourier's series.

The business communications (part 1 for 1912) contain the prize-subjects proposed by the society, the eleventh report of the Samoa Observatory for 1911–12, and a memoir of Sir Joseph Dalton Hooker by A. Peter.

BOOKS RECEIVED.

Les Anaglyphes Géométriques. By H. Vuibert. Pp. 32. (Paris: Vuibert.)

Die Zustandsgleichung. By Prof. H. K. Onnes and W. H. Keesom. Pp. 615–945. (Leipzig: B. G. Teubner.)

Animal Secrets Told. By H. C. Brearley. Pp. xvi+274. (London: Headley Bros.) 5s. net.

Tabellen der Luftgewichte γ_t^b, der Druckäquivalente β_t^b und der Gravitation g. By Dr. S. Riefler. Pp. iv+102. (Berlin: J. Springer.) 6 marks.

A School Economic Atlas. By Dr. J. G. Bartholomew. With Introduction by Prof. L. W. Lyde. Revised edition. Pp. xii+64. (Oxford: Clarendon Press.) 2s. 6d. net.

Map Projections. By A. R. Hinks. Pp. xii+126. (Cambridge University Press.) 5s. net.

The A.B.C. Guide to Astronomy. By Mrs. H. P. Hawkins. Second edition. Pp. iv+120. (London: Simpkin and Co., Ltd.) 1s. 6d. net.

The Tribes of Northern and Central Kordofán. By H. A. MacMichael. Pp. xv+259. (Cambridge University Press.) 10s. 6d. net.

Statics, including Hydrostatics and the Elements of the Theory of Elasticity. By Prof. H. Lamb. Pp. xii+341. (Cambridge University Press.) 10s. 6d. net.

The Annual of the British School at Athens. No. XVII. Session 1910–11. Pp. liv+335+xxi plates. (London: Macmillan and Co., Ltd.) 25s. net.

An Introduction to Algebraical Geometry. By Dr. A. Clement-Jones. Pp. 548. (Oxford: Clarendon Press.) 12s.

Geschlechtszellen und Körperzellen im Tierreich. By Dr. von Berenberg-Gossler. Pp. 22. (Jena: Gustav Fischer.) 60 pfennigs.

The Montessori System. By Dr. T. L. Smith. Pp. x+78. (New York and London: Harper and Brothers.) 2s. 6d. net.

Die Gattung Hedera. By F. Tobler. Pp. v+151. (Jena: G. Fischer.) 6.50 marks.

Picturesque Nepal. By P. Brown. Pp. xvi+205. (London: A. and C. Black.) 7s. 6d. net.

The Naturalist in Siluria. By Capt. Mayne Reid. Cheap edition. Pp. 240. (London: The Year Book Press.) 2s. net.

The Calculus. By Prof. E. W. Davis, assisted by Prof. W. C. Brenke. Edited by E. R. Hedrick. Pp. xx+63. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 8s. 6d. net.

A Laboratory Manual in Chemistry. By Profs. W. C. Morgan and J. A. Lyman. Pp. xiii+142. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 1s. 8d. net.

The Beginner in Poultry. By C. S. Valentine. Pp. x+450. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 6s. 6d. net.

A College Text-book on Quantitative Analysis. By Dr. H. R. Moody. Pp. vi+165. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 5s. 6d. net.

Lecture Notes on Elementary Statics and Dynamics for Intermediate Students. By Prof. J. Sen. Pp. 95. (Calcutta: Hilton and Co.) 1s.

Ueber die krankhaften Erbanlagen des Mannes. By F. Lenz. Pp. 170. (Jena: G. Fischer.) 4.50 marks.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 25.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Characteristic Dynamical Diagrams for the Motion of a Train during the Accelerating and Retarding Periods: Prof. W. E. Dalby.

PHYSICAL SOCIETY, at 5.—The Constitution of Mercury Lines examined by an Echelon Grating and a Lummer-Gehrcke Plate: Prof. H. Nagaoka and T. Takamine.—Note on the Mutual Inductance of Two Coaxial Circular Currents: Prof. H. Nagaoka.—The Absorption of Gas in Vacuum Tubes: S. E. Hill.

SATURDAY, OCTOBER 26.

ESSEX FIELD CLUB (at the Essex Museum, Stratford, Essex), at 6.—Some Recent Observations of the Physiography of the Stort Valley, with special reference to the Rubble-Drift Deposits Rev. Dr. Irving and Percy A. Irving.—Report of Club's Delegates at the Dundee Meeting of the British Association: W. Whitaker and Joseph Wilson.

TUESDAY, OCTOBER 29.

ZOOLOGICAL SOCIETY, at 8.30.—(1) "*Gazella hayi*" = *Gazella fuscifrons*; (2) The Bornean Bantin: R. Lydekker.—Notes on the Breeding of the "Millions" Fish (*Girardinus pœciloides*): E. G. Boulenger.—The Crustacea Isopoda of the *Porcupine* Expedition: Rev. T. R. R. Stebbing.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—VII. On Six Species of Tapeworms from Reptiles belonging to the Genus Ichthyotænia (s.l.): Dr. F. E. Beddard.—Descriptions of New Butterflies of the Genus Thecla from S.E. Brazil: E. Dukinfield Jones.

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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THURSDAY, OCTOBER 31, 1912.

THEORIES OF SOLUTIONS.

Theories of Solutions. By Svante Arrhenius. Pp. xx+247. (New Haven: Yale University Press; London: Oxford University Press, 1912.) Price 12*s.* 6*d.* net.

THE publication of Prof. Arrhenius's Silliman lectures on "Theories of Solutions," delivered at Yale in the spring of 1911, will be welcomed by all who are interested in the present position of physical chemistry. The book is of special value because the author has dealt very lightly with those aspects of his theory of "electrolytic dissociation" which have been discussed over and over again during the last twenty-five years and have occupied so large a space in nearly all recent text-books of physical chemistry. Thus, although many of his illustrations are drawn from electrolytic solutions, only three of the eleven lectures deal specifically with such solutions, namely, those on "The Theory of Electrolytic Dissociation," "Conductivity of Strong Electrolytes," and "Abnormality of Strong Electrolytes."

A special feature of the lectures is the historical method of treatment, which is adopted, not only in the first lecture, on "The History of the Theory of Solutions," but throughout the whole course. The author is, indeed, anxious to demonstrate that the newer views of the nature of solutions were a natural and logical development from those that had been in vogue previously, and seeks to disclaim the idea that he and his co-workers in this field originated a revolution which was in any sense a complete break with the past

The most fascinating lecture of the series is that on "The Modern Molecular Theory." To the average chemist it will be a complete revelation to know how accurately the actual masses of the molecules have been determined in recent years. These masses are recorded most conveniently by determining the magnitude of the constant N, the number of molecules in a gram-molecule, which is, naturally, the same for all molecules. Three methods used by Perrin and based upon the behaviour of minute suspended particles gave for N the values 68×10^{22}, 65×10^{22} and 71×10^{22}; three methods based upon the study of radioactive substances, including, for instance, the actual counting of α-particles, have given the figures 62×10^{22}, 71×10^{22} and 71×10^{22}. Other methods have given 71×10^{22}, 62×10^{22} and 62×10^{22}. It is indeed remarkable that nine series of determinations should agree thus together, the extreme range being only ± 6 per cent.

Other topics dealt with are "Suspension," "Adsorption," "Velocity of Reaction," "Equilibria in Solutions," and "The Doctrine of Energy." In the introduction, the author expresses the view that modern physical chemistry is largely synonymous with "theoretical chemistry," one of its chief functions being to express in mathematical form the experimental measurements of physicists and chemists; that he himself has not lost his skill in this art is shown by the introduction of some new formulæ in the present volume; that even more far-reaching results may flow from this method of working is clear from the use which has been made by Perrin, Lindemann and others of the formulæ developed within the last five years by Einstein.

It is a matter for regret that a book of small dimensions should have been issued at so prohibitive a price as to confine it very largely to reference libraries. The trustees of the "Silliman Foundation" would fulfil the purposes of the trust with much greater efficiency if they could arrange to circulate the printed lectures on more reasonable terms to a much larger circle of readers.

T. M. L.

INTRODUCTIONS TO BIOLOGICAL STUDY.

(1) *A Guide for the Study of Animals.* By Worrallo Whitney, Frederic C. Lucas, Harold B. Shinn, and Mabel E. Smallwood. Pp. ix+197. (Boston, New York, Chicago: D. C. Heath and Co.) Price 2*s.*

(2) *College Zoology.* By Prof. Robert W. Hegner. Pp. xxv+733. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 11*s.* net.

(3) *Einführung in die Biologie.* By Prof. Karl Kraepelin. Dritte, verbesserte Auflage. Pp. viii+356. (Leipzig and Berlin: B. G. Teubner, 1912.) Price 4.80 marks.

(1). THE teaching of biology is much more widely spread amongst American than among British schools, and the need for systematised courses of instruction in natural history is there greater than with us. In this work compiled by science teachers of Chicago high schools a graduated course of zoological teaching is drawn up, beginning with observations on house-flies and ending with some very good suggestions on the use of domestic breeds of animals as object lessons. So far as this suggested course goes, the book may be of considerable help to teachers in search of a suitable curriculum. The greater part of the work is, however, devoted to lists of questions that any good teacher could draw up without assistance. Some of the questions are badly worded or unanswerable; for example, "Compared with a hydra, how many cells has an earthworm?"

K

We have some difficulty in judging adequately of this book, since sixteen pages have been left out in binding up the review copy.

(2) For the most part Dr. Hegner's book runs on the familiar lines of comparative anatomy, and his treatment of the structure of animal phyla does not differ essentially from that adopted in any of the recent text-books of zoology, to which, indeed, he is indebted for most of his subject-matter and illustrations. The feature that he claims to be distinctive in this work is the consideration of animal physiology alongside of animal structure. The difficulty has been to compress a treatment of two such large subjects into the compass of a handy volume. Comparative physiology is in itself a large and new subject and would easily require a whole volume of this size. The author has cut the knot by reducing both anatomy and physiology to a condensed form that can scarcely be assimilated by any student. The physiological paragraphs deal mainly with responses to simple forms of stimulation—the behaviour of Paramecium and of Hydra are excellent examples of this—but they do not attempt to show the evolution of physiology amongst animals as do the sections upon anatomy.

Some useful sections are devoted to showing the economic bearing of zoological knowledge. The statement of the food of birds is a good instance of this, though here, again, the need for brief summaries has precluded the insertion of much interesting matter. The remarks on the damage due to insects, for example, are too brief to be of much value.

Compression has been carried too far in the case of invertebrates of uncertain affinities in chapter ix. Either these groups should have been omitted or treated more fully. On the whole the chapter on insects strikes one as being the best in the work, and the treatment of the affinities of animal phyla as the least satisfactory feature of it. The use of the terms "efferent" and "afferent" in connection with the circulation of the crayfish, on p. 283, is the converse of general usage and may lead to considerable confusion. The illustrations are very good and clear; those of the honey-bee, though not original, are sure to be welcome. Fig. 369 is turned upside down. Perhaps the greatest appeal of this very carefully compiled work will be to those who wish to have a book on comparative anatomy in one volume.

(3) This work, by the director of the Natural History Museum at Hamburg, has run into three editions in less than six years, and its success is due to the clear and well-balanced treatment that it contains of both branches of biology. In the present edition the sections on comparative anatomy and on the early races of mankind have been expanded and brought up to date so as to make an exceptionally attractive and very cheap work. Dealing, as the book does, mainly with general problems, it seems rather a pity that the statement of Mendel's method is not clearly given. The essence of the method and its importance can be stated quite simply without going into details. The account that is given here, printed, as it is, in minute type and dealing with a single case, will no doubt be expanded or altered in the next edition.

PHYSICS: OLD AND NEW.

(1) *Junior Magnetism and Electricity.* By Dr. R. H. Jude and Dr. J. Satterly. Pp. vii + 288. (London: W. B. Clive, University Tutorial Press, Ltd., 1912.) Price 2*s.* 6*d.*

(2) *An Introduction to Practical Physics for Colleges and Schools.* By Prof. E. H. Barton and Dr. T. P. Black. Pp. vii + 188; illustrated. (London: Edward Arnold, 1912.) Price 3*s.* 6*d.*

(3) *Mémoires sur l'Électricité et l'Optique.* By A Potier. Publiés et Annotés par A. Blondel. Avec une Préface de Henri Poincaré. Pp. xx + 330. (Paris: Gauthier-Villars, 1912.) Price 13 francs.

(4) *Treatise on Light.* In which are explained the causes of that which occurs in Reflexion, and in Refraction, and particularly in the strange Refraction of Iceland Crystal. By Christiaan Huygens. Rendered into English by Silvanus P. Thompson. Pp. xii + 129. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* net.

(5) *Intermediate Physics.* By Prof. W. Watson, F.R.S. Pp. xiii + 564. With diagrams. (London: Longmans, Green and Co., 1912.) Price 6*s.* net.

(6) *Lehrbuch der Physik.* By Prof. Eduard Riecke. Erster Band. Mechanik, Molekularerscheinungen und Akustik. Optik. Zweiter Band. Magnetismus und Elektrizität. Wärme. Fünfte, verbesserte und vermehrte Auflage. Pp. xvi + 600 + xii + 775; illustrated. (Leipzig: Veit and Co., 1912.) Price 26 marks. 2 Vols.

(7) *Physik in graphischen Darstellungen.* By Felix Auerbach Pp. x + 28 + 213 plates. (Leipzig and Berlin: B. G. Teubner, 1912.) Price 9 marks.

(1) SO many elementary text-books of this kind appear from time to time (one of the present authors is already responsible for two) that it is very difficult to judge whether or not a new publication possesses advantages over its predecessors. The scope of the subject is so limited that all of them are bound to be very much alike, and in any one book there can only be a

few special features which demand attention. In the present case little can be said but that the authors have presented what appears to be a straightforward and clear account of the elements of the subject.

The general method of treatment is based upon the two previous text-books of Dr. Jude, more stress being now laid, however, on the practical side of the subject. Descriptions of a large number of experiments with simple apparatus are inserted in the text, and the diagrams are rather more frequent than is usually the case. It is rather a pity that some of the latter, which are evidently new, have not been printed more clearly. An unsatisfactory feature (which, however, it should in fairness be stated, is by no means peculiar to this case) is the mode of definition of the units in electromagnetism. Even if it be admitted that exact definitions are beyond the scope of this work, a *volt* should not be defined as "10/11 of the electromotive force of a Daniell's cell" without further explanation. Surely, also, the unit of current could be explained from first principles and not be defined in terms of the *volt* and the *ohm*.

(2) Here, again, we have a further addition to the numerous works on elementary practical physics. This book is, however, rather more advanced than those which have lately appeared, and, although no previous knowledge of physics is assumed, the authors claim that it contains more than sufficient matter for the intermediate examination for degrees, almost enough, in fact, for the pass final examinations. One serious objection to the publication of books of instruction in practical work is that in different laboratories different types of apparatus are usually found, a fact which would tend to limit the usefulness of the book to the students under the direction of the author, who generally bases his work upon his own course. This the present authors have endeavoured to avoid by describing experiments involving the use of standard apparatus, or that which can easily be made.

The arrangement of the book is excellent. Some 120 experiments are described and each exercise is divided as follows: apparatus, object of experiment, theory and results. It is not intended that the instructions printed should form the whole information given to the student. This also is a good feature, for it is certain that no thorough teaching of practical physics is possible if the services of the demonstrator are dispensed with.

(3) The collection into one volume of the mathematical and physical researches of the late M. Potier is certain to direct the attention of men of science, whether physicists, mathematicians or engineers, to the wonderful versatility of the author and to demand their admiration. When it is remembered that M. Potier's geological researches (which are not included in the present collection) have rendered him eminent in that subject also, his wonderful ability becomes still more apparent. As M. Henri Poincaré (himself, unfortunately, deceased since the publication of this volume) points out in the preface, Potier was a mathematician, and undertook very little experimental work, but he nevertheless kept in touch with the results obtained by others and endeavoured to conform his mathematical researches to the experimental requirements of the case. Especially is this so in his most important papers on applied electricity, which are compiled in the second part of this volume. Indeed, his services to electrical engineering are regarded as forming the most brilliant part of his work. In the first part the memoirs on electrical theory are collected, and the third part contains those dealing with many and varied questions in light.

(4) It is indeed surprising (as the translator points out) that no English edition of this treatise of Huygens has until now appeared. Two hundred and twenty years have elapsed since the original saw light, and in the interval it has produced a more pronounced effect on the science of optics than almost any other work. It is, therefore, a matter for congratulation that the long-delayed edition is an excellent one, and it will be welcomed by all those who find delight in reading the writings of the masters in science. Not the least pleasing feature of Prof. Thompson's translation is the preservation of the old-time mode of statement, which recalls the earlier English editions of Newton's "Principia." Prof. Thompson's reason for a literal rendering is, however, more fundamental than that of making reading pleasant. He wished to avoid "importing into the author's text ideas of a subsequent date, by using words that have come to imply modern conceptions." The publishers have carried out the idea of antiquity in the type and binding and have produced a really beautiful book.

(5) Here is a book which will undoubtedly fill a gap in the various publications on physics. There is a large class of students who do not carry their studies in physics beyond the intermediate stage, branching off into engineering or medicine at that point. As a general rule, no suitable text-book provision has yet been possible in such cases. The single volumes on physics already in existence are either too simple or too difficult, and the students in question have objections to purchasing separate volumes in the various branches of the subject. It appears fairly certain, therefore, that this book of Dr. Watson's will play a

part in the more elementary stages of physics similar to that which his well-known text-book has done and continues to do in the later stages.

Considering the amount of matter involved, it is, perhaps, not surprising that the treatment seems somewhat disjointed in the abrupt passages from one section to the next. This is most marked in the part on mechanics, which, however, the author tells us, is only included on account of the requirements in the main part of the book. As a consequence, it is doubtful whether it would be possible for a student to master the subject by unaided reading; but, after all, that should not be the purpose of a text-book. It should be regarded as an aid to oral instruction. The printing and diagrams are good and in many respects the book is unique.

(6) The fifth edition of Prof. Riecke's excellent text-book has been improved and extended in various ways. On one hand we have more complete treatment of such subjects as radio-activity and the conduction of electricity in gases, which in the earlier editions were only touched upon. On the other hand, there is the introduction of new matter, comprising liquid crystals, Brownian movements and the work of Michelson and of Nernst. Like most of the German standard text-books, this one is much more complete than corresponding works in English, and it is greatly to the credit of the authors that they spare no trouble to bring the new editions of their books really up-to-date. The printing and diagrams are very much above the average. Surely there could be no better testimony of the worth of a scientific book than that it is now in its fifth edition.

(7) This book is quite a novelty. It consists of nearly fourteen hundred diagrams—curves, photographs, &c.—representing physical facts, with short explanations of each collected at the end of the book. Although, of course, it could not be regarded as a substitute for an ordinary text-book, it might well be a useful companion to the latter. The arrangements of the diagrams is occasionally somewhat inelegant, doubtless due to space considerations, but they are, as a general rule, well printed, and in every case what is represented is clearly indicated.

OUR BOOKSHELF.

Modern Problems. By Sir Oliver Lodge, F.R.S. Pp. vii + 320. (London: Methuen and Co., Ltd., 1912.) Price 5*s.* net.

A COLLECTION of essays which have for the most part appeared before as articles or addresses, but which were well worth gathering together and publishing in more permanent form. The subjects dealt with are chiefly social and philosophic—the function of money, universal arbitration and the irrationality of war, Poor Law reform, the position of woman, the drink question, the nature of time, the philosophy of Bergson—these will indicate the wide scope of the book. All the chapters are characterised by the admirably lucid yet thorough exposition which Sir Oliver Lodge's writings always present; and the conclusions, definite though cool and undogmatic, are full of that ripe wisdom which only a wide human outlook on life can give.

From the scientific point of view, one of the most interesting chapters is that on the smoke nuisance, in which the author deals with the problems of combustion, and advocates the use of gas fires and the suppression of crude combustion of coal in towns. As to river and sea mists, and fogs of non-avoidable kind, Sir Oliver suggests electrification of the atmosphere on a large scale, a plan which he has brought within measurable distance of application. This matter is again touched on in the chapter "Squandering a Surplus." No one can tell for certain what would happen by this atmospheric electrification, but it is possible and even probable that the results might be of incalculable benefit; crops might be assisted, rain produced, fog dissipated. When we think of the tremendous harmfulness of fog, financially and to the health of our citizens, it seems obvious that the prospect of a cure of this evil would justify a large national grant for expenditure on trials in a large way. It is to be hoped something of the sort may yet be done.

J. A. H.

Chrysanthemums. By T. Stevenson. With Chapters by C. H. Payne and C. E. Shea. Pp. xiv + 112. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1*s.* 6*d.* net.

THIS is the latest addition to the admirable "Present-Day Gardening" series, edited by Mr. R. Hooper Pearson. It appears at an appropriate time and will interest as well as instruct all who are concerned with the culture of chrysanthemums, whether for pleasure or profit. Though there is no reference to the existence of the plant in English gardens before 1764, it was mentioned by Confucius five hundred years or so before the commencement of our era. In the first third of the nineteenth century, about fifty varieties were known to English growers; and no attempt had been made to raise new varieties from seed. The first novelties obtained from seeds were exhibited by Mr. I. Wheeler, of Oxford, in 1832; and since then hundreds of beautiful forms have been produced. In the volume before us, details are given as to the procedure in raising seedlings and creating new varieties; and also particulars as to the care of chrysanthemums in all stages of their growth. The book will delight and assist all growers of the plant, and is a valuable addition to a series which should be known to all lovers of gardening. There are eight coloured plates showing typical flowers, and lists of varieties for cultivation as decorative plants or flowers.

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.]*

The Sub-Crag Flint Implements.

The series of flints from the sub-Crag detritus bed, collected by Mr. J. Reid Moir, and figured in my paper in the Phil. Trans. of May, 1912, are now placed in the Ethnological Department of the British Museum, Bloomsbury, under the care of Sir Hercules Read, K.C.B., keeper of that department. So many archæologists have been anxious to see them that I have been glad to avail myself of Sir Hercules Read's kind offer to place them on view, and to allow serious students to have access to them. They include the highly flaked, somewhat hooked specimen from the mid-glacial sands of Ipswich (Fig. 6 of my memoir), and the well-shaped rostro-carinate implement of the same age from Foxhall (Figs. 2 and 3 of my memoir). Besides seven well-marked rostro-carinate sub-Crag implements, the series includes the large and heavy flint with a "Chellean" flaking on both faces at one end (Figs. 38, 39, and 40 of my memoir) and several smaller pieces which, if found in river gravels, would be admitted at once as typical scrapers and borers; also the curious four-sided pyramid figured in my memoir (Figs. 25 and 26).

It will now be possible for prehistorians to discuss the probability of these pieces having been flaked by human agency, with the actual specimens in their hands. There is, I may say, no possibility of a doubt as to the provenance of these flints. With the exception of the two mid-glacial pieces, they all come from the remarkable and well-defined Suffolk bone-bed, or detritus bed, at the very base of the Red Crag. Further, there is no doubt that this deposit was not laid down under torrential action nor on a wave-beaten shore; nor are the pieces in it fractured by any kind of pressure or disturbance *in situ*. They were tranquilly deposited where they are, and many have the small Balanus of the Crag sea affixed to their broken surfaces.

To the question, "How have these flints been fractured so as to give them their present form?" three different answers are given by three separate groups of observers. One group maintains that they have been thus fractured by being knocked together by heavy torrential waters or by waves breaking on a beach; a second group says that they have been broken after deposition by the pressure of superincumbent deposit (or possibly by glacier-like ice moving on and above the deposit); a third group, of which I am one, points to the definite form (rostro-carinate, Chellean, scraper) given by the fracture, and considers it impossible, in our present state of knowledge of the fracture of flint, to attribute this definite and apparently purposeful fracturing to any coincidence of natural breakage, and attributes them to human design and action.

In reference to these diverging views, it is necessary to take account of the facts (1) that it is generally admitted that such forms as these are what we should expect to find as the earlier work of man, preceding the more skilfully worked implements of the river gravels; (2) that no specimens of flints fractured by torrential or by wave action of water and corresponding in size, in form, and definite shaping to the sub-Crag flints have as yet been discovered or produced experimentally. The broken flints of the flint-mill at Mantes, put forward by M. Boule, have no resemblance to them; nor have the pebbles, with an occasional small fracture on the surface, from the beach at Sherringham (Norfolk) any resemblance to them. The advocates of torrential or wave action of water have yet to take the initial step of showing that such action can actually produce anything of the sort. Moreover, they have to show that there is independent evidence of a possibility, let alone a probability, of the sub-Crag flints having been exposed to violent interconcussion by water. The "violent concussion theory" is, at present, without a single fact in its support. (3) We have to recognise that no specimens of flints fractured by pressure in natural conditions have been "laid on the table" which in any way resemble the sub-Crag implements. The fractured fragments of flint procured by M. Breuil at Bel Assize (which I have examined) have no resemblance to them. Moreover, there is no evidence to show that M. Breuil's specimens were, as he asserts, broken by the pressure of superposed deposits. On the contrary, no such fracture by the weight of superposed sandy strata can be admitted. According to ascertained facts as to the transmission of pressure by sand, there is no reason to suppose that fracture can be so produced.

In regard to this suggestion, as in regard to that of torrential action, the careful examination of the deposit in which the sub-Crag flints of Suffolk occur renders it absolutely certain that no such pressure has acted upon the flints where they at present are found. Here, again, we are referred (by M. Breuil's supporters) to some unknown and fanciful precedent conditions (of which there is no evidence) in order that the impossible crushing by a superposed sandy deposit may take place. (4) We must note that the hypothesis that these flints were purposely fractured by man is the only one which explains their special shape and the "directed" character of the blows which produced the fractures and the shape. It is also the only hypothesis which accounts for the fact, pointed out to me by Prof. Flinders Petrie, that all of these fractured flints from the sub-Crag bed, shaped according to definite and special pattern, readily fit to the hand and at once fall into position as useful picks or hammers. It may be said that we have no independent evidence of the existence of man at this epoch, just as we have no evidence of torrential waters or vast pressure. But I have reason to believe that such independent evidence of man's presence at this epoch in this country is already in the hands of competent geologists, and will soon be made public.

Lastly, I may say a word as to the remarkable scratching of the fractured surface of many of these flints. I have attributed it to the action of ice, similar to (but not precisely identical with) that which causes the scratching of rocks and rock pebbles by modern glaciers. There is other evidence, as noticed by Lyell, for the presence of ice—transporting large blocks of flint in an unrolled condition—during the deposition of the Suffolk bone-bed at the base of the Reg Crag. But the human origin of the fracturing of the flints we are discussing is not bound up with the hypothesis that the scratches on them are due to ice-action. I am not aware of any evidence in favour of any other explanation of the presence of these scratches.

It is very evident to me, from the various opinions which have been expressed in regard to the history of the sub-Crag flints, which I consider to be implements fabricated by man, that there is an extraordinary lack of precise information, at this moment, as to the properties of flint, the various possible causes of its fracture (including heat and cold, as well as blows and pressure), and the means of judging what particular causes have been at work in fracturing any given specimen. It is in consequence of the vagueness of published and approved statements on the properties of flint that we are asked to accept all sorts of indefinite appeals to natural agencies as sufficient to account for what no one, without uncommon faith in the unknown possibilities of those agencies, would be capable of imagining as due to any other agency than the hand of man.

To avoid, if possible, any misunderstanding, let me say that the sub-Crag flint implements are not "eoliths" in the sense given to that word by Mr. Benjamin Harrison, nor in that given to it by M. Rutot. Still less are they to be called "eoliths" by those who would apply that term to flints broken by cartwheels or by the mill at Mantes.

I propose to sketch in a later communication a programme of inquiry into the nature and properties of flint, the carrying out of which seems to me to be urgently needed at this moment.

October 29. E. RAY LANKESTER.

High Tropical Winds.

LAST year, in a letter to the Editor of this journal (vol. lxxxvii, p. 415), I wrote about the probable existence of "upper trade-winds," according to the observation of some high balloon flights at Batavia. Also I ventured to explain the occurrence of high westerly winds near the equator by supposing them to be only feeble winds of variable direction between the anti-trade and the upper trade. Finally, I mentioned my intention of continuing these researches by means of large pilot-balloons.

This has been done in the past year, but the average height reached by the balloons was lower than I wished, owing to the inferior quality of some of them. Notwithstanding this, the results are of sufficient interest to justify a short account of them.

Contrary to my expectations, I found the high westerly winds (first met by Berson on the Central Africa expedition) not to be of secondary, but of primary importance; moreover, not blowing under but above the anti-trades.

On four different occasions a balloon crossed the upper limit of the westerly winds and again met easterly currents.

As I had already conjectured from the observations made during the two preceding years (1910–11), the anti-trade in the dry season (June–September) lies higher than in the rainy season (December–March); thus I found the average height of its upper limit to be :—

December–March ... ... 16·5 km. (9 cases).
June–September ... ... 15·5 km. (18 cases).

In the months of transition its direction may vary a good deal, and then it is often difficult to discriminate between the various currents; notwithstanding, six cases gave an average height of 15·8, *i.e.* a height between those of the two monsoon seasons.

Regarding the upper trade, I found it to be, just as I expected, more obvious and at a higher level in the rainy season than in the dry one, its lower limit being :—

December–March ... ... 17·0 km. (9 cases).
June–September ... ... 15·3 km. (13 cases).

On the contrary, the high westerly winds were found to occur in most cases during the dry season, and at a height of more than 17 km.

Also in the months of transition their presence was proved by some balloon flights; for instance, on April 24 and 27, 1912, when two balloons burst at a height of 27·2 and 25·3 km. respectively, and westerly winds appeared to blow from 20·0 and 18·5 km. upwards.

As already mentioned above, this year on four occasions a balloon passed the upper limit of the high westerly winds, viz. on January 24 at a height of 23 km., and on September 7, 12, and 23 at about 24 km.

It is important to remark that Berson had already seen this happen (at a height of 20·2 km.) for the first time at Dar-es-Salaam, but he must have undervalued the height of the balloon, viewing it from one point only, and making use of a theoretical rate of ascent. In reality this rate increases strongly with the height, as I have found by viewing my large pilot-balloons from two points (2 or 4 km. apart).

I estimate Berson's pilot-balloon of 700 gr. must have crossed the upper limit of the westerly winds at about 23 km., accordingly at the same level as those which ascended at Batavia.

The balloon of September 12 burst at the enormous height of 30,800 m., and gave evidence of the strong easterly winds which have long been supposed to blow at a great height above the tropical belt.

Thus for the first time has been described the wind which, during the period of 1883, August 27–September 8, carried the ashes of Krakatoa around the earth at a level of ±30 km., and at a velocity of 34 m.p.sec., and therefore may properly be called Krakatoa wind.

The wind directions and velocities observed on September 12 follow below :—

Height in km.	Wind blows from	Velocity in m.p. sec.	Name of air-current
0·3	S	6	Land breeze
1	E 17° S	2	
2	E 4 N	5	Trade-wind
3	E 14 S	5	
4	E 23 N	5	
5	E 15 N	6	
6	E 20 S	9	
7	E	7	
8	E 42 N	12	
9	E 25 N	17	
10	E 8 N	11	Anti-trade wind
11	E 18 N	14	
12	E 57 N	13	
13	E 47 N	16	
14	E 28 N	23	
15	E 21 N	19	
16	E 54 N	13	
17	E 29 N	9	
17·5	E 42 S	7	Upper trade wind
18	E 8 S	1	
19	W 17 S	10	
20	W 12 S	12	
21	W 13 N	11	High westerly winds
22	W 30 N	16	
23	W 7 S	12	
24	S 9 E	8	
25	E 81 N	5	
26	E 20 N	7	
27	E 43 N	9	
28	E 2 S	11	Krakatoa wind
29	E 21 S	19	
29·5	E 6 N	40	
30	E 8 N	33	
30·5	E 9 N	34	

On September 7 and 23 the same wind system reigned, as was proved by two balloons which reached a height of 26·5 and 27·5 km. respectively.

Regarding the explanation of the occurrence of high westerly winds near the equator, Gold (Quarterly Journal, 1910, p. 178) reminds us of the theoretical results of Overbeck, from which, according to him, might easily be deducted that often at great heights the vast westerly whirl around the poles extends over the tropical belt. But the principles on which Overbeck built his theory are not in agreement with reality. He regards difference of temperature as the *prima causa* of the air-currents, and presumes the vertical distribution of temperature to be caused by conduction only, supposing other causes, such as radiation, vertical currents, &c., to give an analogous distribution as conduction gives it.

The existence of the stratosphere has taught us, however, that this is not the case.

Though it seems rational to presume that the high westerly winds are an extension of those at higher latitudes ($\pm 15°$), and also that the Krakatoa wind comes from still higher latitudes, being deflected by the rotation of the earth in an easterly direction, more observational data from other stations are urgently wanting for a thorough explanation of the facts.

Batavia, September 24. W. van Bemmelen.

The Blind Prawn of Galilee.

In describing the eyeless prawn from Galilee that he named *Typhlocaris galilea*, Dr. Calman stated that, according to the information at his disposal, it was found in a small pool near the town of Tiberias communicating with the lake and fed by a mineral spring (see Trans. Linn. Soc., London, 2nd ser., zool. xi., p. 93, 1909). As Typhlocaris is one of the most peculiar crustacean genera described of recent years, further particulars as to its *provenance* may be of interest to naturalists. The pool in which alone, so far as is known, it occurs is situated some two hundred yards from the Lake of Tiberias, an hour and a half's sail north of the town of that name. Originally this pool was one of the chambers in a Roman bath at some forgotten city, perhaps Capernaum or Bethsaida. It is still completely enclosed by stout masonry which gives it a symmetrically octagonal outline, but its surface is choked with gigantic floating grasses. There is now no visible outflow or inflow of water, which apparently percolates through the bottom at several places and decreases in volume by desiccation. As its temperature is distinctly lower than that of the water in the aqueduct that works a corn-mill between it and the lake, it seems improbable that there is any great outward percolation. It is evident, however, that the water, which even now is nowhere less than about 4 ft. deep, was in ancient times much deeper, and that the overflow was conducted away by means of apertures in the wall high above the present surface, while there are traces of an aperture through which it may have entered the pool in volume in a masonry platform that juts out into the pool from one of its eight sides. The water is slightly saline, but not so markedly so as that of some springs in the vicinity.

The first Typhlocaris that I saw on a recent visit to the pool was crawling on the side of the platform about three feet below the surface, making its way slowly in and out of the crevices. Apparently the claws as well as the antennæ were used in testing the surface along which it moved. A piece of bird's flesh weighted with a small stone was lowered on a string to attract it away from the stones and render its capture more easy. It seized the string in both its claws and gave it a vigorous tug. It then made its way to the flesh, but when the latter was forthwith attacked by a number of small fish (*Discognathus lamta*), the prawn moved away. Although the fish made no attempt to injure it, it invariably avoided them. When touched with a net it darted violently backwards, straightening its claws in front of it as it did so, but no great difficulty was experienced in capturing it. At the time of our visit (about 5 p.m.) the pool was in shade, but the prawn did not seem to avoid such light as reached it. A second individual was seen crawling on the bottom at dusk, but none were seen in the early morning.

There was no trace of colour on the living prawn, except that the internal organs of the thoracic region produced a dusky blotch externally. The whole body was otherwise of a semi-opaque white like that of paraffin-wax.

The appearance of Typhlocaris in the pool is most erratic. Herr Grossmann, who sent the first specimens to the British Museum and assisted me greatly in my search for more, tells me that he has often visited the pool without seeing any, and one of the German fathers who have a hospice in the neighbourhood stated that while on one occasion a Bedouin caught five individuals in a single day, on another none were seen for six months. On the whole, I agree with Dr. Calman in thinking that the real habitat of Typhlocaris is subterranean, but I have little doubt that having once made their way through some crevice into the pool, individuals are able to flourish there, hiding in crevices in the walls or under the vegetation that floats on the surface. N. Annandale.

Tiberias, Palestine, October 8, 1912.

Is the Earth Shrinking?

In a recent popular work I find the statement, "The earth is still slowly shrinking. . . ." I am aware that this statement fits in with our preconceptions and may even appear trite and commonplace, but it is sometimes just such statements that best repay investigation. I would, therefore, inquire whether there is any unequivocal evidence that the volume of the earth as a whole either is now suffering, or has in the past suffered, progressive diminution.

If there were direct evidence of progressive cooling on the part of the earth, diminution of volume would be almost a necessary inference, but on this point I understand that geological evidence is by no means favourable. As regards the presence in various regions of folding, overthrusting, reversed faulting, &c., such phenomena are evidence of surface compression in regions where they are found; and in a precisely similar manner the presence of rifts, fissures, ordinary faulting, &c., is evidence of local surface expansion, although the latter result is seldom emphasised. In a given region it is easy to picture such a combination of folding with fissures cutting across the folds as would cause the region to suffer distortion without either diminution or increase of superficial area. If such be conceivable within the limits of a local region, it is evident that the mere presence of folding and the like, unsupported by an intricate quantitative examination, will not warrant the conclusion that the earth as a whole is shrinking. On the other hand, if due regard be paid to the physical properties of the materials composing the earth's crust, is it not remarkable that extensive regions exist which do not appear—at least in geologically recent times—to have suffered compression?

October 13. H. Birrell.

For a quantitative discussion of the effects of secular cooling on the earth's crust, Mr. Birrell may be referred to a couple of papers by Dr. C. Davison and Sir George Darwin in the Philosophical Transactions of the Royal Society for 1887. He will find that though the speculative nature of the assumption is frankly confessed, yet the observed phenomena are shown to be consistent with the theory of contraction and secular cooling. On the whole, students of cosmogony (as opposed to geology), arguing to some extent from the analogy of other celestial bodies, are in agreement in accepting the hypothesis of secular cooling. A notable exception is Prof. F. R. Moulton, of Chicago. In conjunction with Prof. T. C. Chamberlin, he has developed a "planetesimal hypothesis," according to which the earth was built up by a series of solid accretions. The hypotheses of secular cooling and initial high velocity of rotation for the earth have no place in his theory. For details Mr. Birrell may be referred to "The Tidal and other Problems" (Carnegie Institution of Washington, 1909).

F. J. M. Stratton.

NEW OBSERVATIONS ON HUMBLE-BEES.[1]

THIS account of the humble-bee has a merit very uncommon in popular books of natural history; it is written by a naturalist who has spent years in observing for himself, and whose observations are numerous, original and interesting. There are set before us new facts concerning (among other things) the domestic management of several humble-bees, the packing of pollen into the collecting basket, the habits of the parasitic bee, Psithyrus, the insect-devourers of the broods of humble-bees, or of the food-supply stored in the nest, and the perfume of male humble-bees, besides many practical suggestions for the tending of humble-bee families in captivity. The different species are pictured in excellent colour-photographs, which will save trouble to observers who are not yet practised in systematic identification, and there are useful photographs of humble-bee nests, combs and incubating females.

FIG. 1.—Comb of *Bombus agrorum*, showing pollen-pockets in the sides of the bunches of larvæ. From "The Humble-Bee."

May we suggest to the author that, if an opportunity offers of revising his work, he would do well to prefix a simple account of the life-history and economy of some one humble-bee? There is a choice of such histories in Réaumur, each marked by a lucidity and grace which captivate the reader. One of these, shortened and revised, would meet a want which many readers are likely to have felt. It is singular that Réaumur is never mentioned by Mr. Sladen, though room has been found for a longish quotation from the Abbé Pluche!

Mr. Sladen's excellent matter is not always well arranged; we have found it troublesome to recover passages the place of which in the book had not been noted. Our author seems to suppose that humble-bees give out heat whenever they are active. Can this belief be supported by thermometer readings? There is a hint, too, but not more than a hint, of blood-vessels filled with a red fluid. We are convinced that this supposition (if really entertained) is a delusion. Corrigenda like these are trifles. Our main duty is to recognise Mr. Sladen as a careful and clever observer, and to recommend his work as a trustworthy account of a particularly interesting group of insects.

Buttel-Reepen (*Biol. Centralbl.*, 1903), drawing upon information contributed by many other naturalists, among whom Mr. Sladen is named, has traced the ascent step by step, from the solitary bees to the complex communities of the honey-bees. In the simplest bee families the life of all the individuals is short, and the mother dies without ever seeing her progeny. Then we pass to bees the females of which regularly outlast the winter; the cells are collected into some kind of comb, and the nest is guarded. In the humble-bees there is a further advance; the labour of the mother is now shared by parthenogenetic workers, though these are only seen during the flowering season, and perish before winter. The climax is reached in what we illogically but conveniently call the honey-bees (the humble-bees also are collectors and storers of honey); of these the hive-bee is the most familiar example. Here the workers persist from year to year, and become supreme, the mother (now called the queen-bee) being degraded to a captive, and incessantly occupied with egg-laying. If the humble-bees had not been carefully studied we could only have guessed at the stages by which the elaborate polity of the hive has been, or may have been, attained.

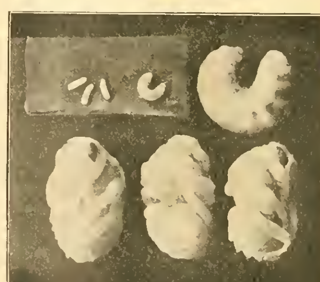

FIG. 2.—Eggs, larvæ and pupæ of *Bombus terrestris*, slightly enlarged. From "The Humble-Bee."

The last news is that Mr. Sladen is joining the staff of the Central Experimental Farm at Ottawa. We wish him all success in his new sphere, and hope that he will not be too much occupied by his work in Canada to give a thought now and then to the Hymenoptera.

L. C. M.

[1] "The Humble-Bee. Its Life-history and how to Domesticate it. With Descriptions of all the British Species of Bombus and Psithyrus." By F. W. L. Sladen. Pp. xiii+283; illustrated. (London: Macmillan and Co., Ltd., 1912.) Price 10s. net.

THE UNVEILING OF A STATUE OF PRIESTLEY AT BIRSTALL.

THE merits of Joseph Priestley—theologian, philosopher, social reformer, and man of science—were recognised by some at least of his contemporaries. He was on terms of friendship with such men as Franklin, Wedgwood, Watt, and Banks, and he enjoyed the patronage and companionship of Lord Shelburne. In 1766 he was elected a fellow of the Royal Society, and seven years later the Copley medal was awarded to him.

To many of his fellow-countrymen, on the other hand, Priestley was but a violent and obstinate schismatic, intent only on undermining the established order of things. It was indeed the intolerant and cruel expression of this view by the Birmingham mob that led him to emigrate to the United States in the sixty-second year of his age.

Such clouds, however, as once obscured Priestley's fair fame have now entirely passed away, and the services which he rendered to the national life, whether as a pioneer of chemical science or as an "honest heretic," are everywhere recognised. Public memorials of the man and his work have been erected in Birmingham, Warrington, and Leeds, and recently another has been added to the number. For the citizens of Birstall, in the West Riding, where Priestley was born in 1733, have combined, with praiseworthy public spirit and enthusiasm, to erect a statue of their eminent townsman.

This latest memorial was unveiled on October 12 by Sir Edward Thorpe, whose ready pen has materially contributed to a just appreciation of Priestley's character and work by this generation. The ceremony was performed in presence of a large and distinguished company, and general satisfaction was expressed at the manner in which the scheme for commemorating Birstall's most famous son had been brought to a successful issue.

After the unveiling ceremony, the company adjourned to the Temperance Hall, where an address was delivered by Sir Edward Thorpe. In an illuminating review of Priestley's life and the various factors that shaped his career, emphasis was laid on the influence of his early environment. From his sixth year onward Priestley was entrusted to the care of his aunt, Mrs. Keighley, a worthy, intelligent, and broad-minded woman, to whose house the cultured people of the neighbourhood were wont to resort. For a time ill-health prevented the boy attending school with regularity, and to a large extent he had to make his way to knowledge unaided. These circumstances, cooperating with his natural keenness and diligence, developed in young Priestley that mental activity and independence which later were characteristic of his attitude towards theological, philosophical, political, and social questions.

After a suitable training Priestley entered the ministry, and worked successively at Needham, Nantwich, and Warrington. It was not until he went to Leeds in 1767 that he began those chemical investigations on which his fame chiefly rests. It is indeed remarkable, as Sir Edward Thorpe pointed out, that a man like Priestley, without previous training, with domestic utensils for his apparatus and tallow candles for his source of heat, should have made the great discoveries in pneumatic chemistry with which his name is associated.

The Priestley Statue at Birstall. Sculptor: Miss Darlington.

It was, however, during his seven years at Calne, in Wiltshire, under the patronage of Lord Shelburne, that Priestley's best experimental work was done. It must be admitted that he did not at all realise the true significance of his investigations. The discovery of oxygen was destined to revolutionise chemical science, and yet Priestley himself, to the end of his days, clung to the antiquated conceptions which his own experiments had really overthrown. In this connection Sir Edward Thorpe has emphasised the striking contrast between Priestley the social, political, and theological reformer, always in advance of his time, and Priestley the conservative and orthodox man of science.

Sir Edward holds that, great as was Priestley's merit as an experimentalist, a greater claim to our regard rests on his struggles and sufferings in the cause of liberty. Unpopularity and even persecution were his lot during his later years in England, and it is to Priestley's everlasting credit that he did not allow these untoward circumstances to disturb his serene and genial temper. In paying tribute to such a man—one whom Frederic Harrison has described as "the hero of the eighteenth century"—the citizens of Birstall have done honour to themselves. J. C. P.

THE PROPOSED MEMORIAL TO LORD LISTER.

MEETING AT THE MANSION HOUSE.

IT may be said that the life of a great man needs no permanent memorial from his contemporaries, and to some extent this is true. Poets, men of letters, and philosophers speak to posterity in their writings, statesmen and warriors have their deeds recorded in history, artists, sculptors, and architects have erected their own monuments which everyone may see. Yet even to them their fellow-men delight to raise some special token of their admiration. But there are others whose work is of a less public character, less obvious to the ordinary observer, and less easily understood, but which often has a more important effect upon the welfare of the world. Of such are the men of science, whose atmosphere is different from that of their fellow-men, and who occupy the *edita doctrina sapientum templa serena*. It is fitting that some permanent memorial should from year to year recall the names of such and remind those who come after of what it is that they have accomplished.

The great meeting which, under the auspices of the venerable Lord Mayor, himself a member of the medical profession, assembled at the Mansion House last week to sanction the project for raising a memorial, or rather some memorials, to Lord Lister, will, we are confident, meet with the approval of everyone, in all parts of the world. The names of those who attended the meeting and those who sent messages of regret at being unable to do so, indicate how wide is the sympathy that it has aroused. Statesmen, ecclesiastics, soldiers, representatives of science and of medicine, of the City companies, of hospitals, and of the general public were all enthusiastic in their commendation of the scheme. Such evidence reminds us that Lister's work was not merely one which revolutionised surgical practice, and was thus instrumental in saving his fellow-creatures from premature death and unnecessary suffering, and enabled the art of surgery to advance by leaps and bounds to a degree undreamt of before; but that its scientific value alone is so great as to justify his being placed amongst the most distinguished men of this or any other age.

The Lord Chancellor, in the unavoidable absence of the Prime Minister, paid an eloquent tribute to Lister's pre-eminence and to the far-reaching effects of his doctrines; yet the man in the street has but little notion of the benefits he has derived from them; he has perhaps learned the two words "antiseptic system," but they convey no meaning to him; and he does not appreciate the dangers which have been averted and the sorrows prevented for him and those who are dearest to him. It is for these that a speaking memorial should be raised, and it is from these, if they can be made to understand its meaning, that we feel sure an appeal for the necessary funds will not be made in vain.

A very influential committee has been formed of representatives of all classes in the United Kingdom and the Colonies and of Ambassadors and Ministers of foreign countries, and in their opinion it is fitting that whatever is done should partake not only of a national, but an international character. This committee, after careful consideration, submitted a scheme to the Mansion House meeting, which met with cordial approval.

The Dean of Westminster, who is a warm sympathiser with it, desired that Lord Lister's ashes should find their final resting-place in Westminster Abbey, but owing to his own very strict injunctions concerning his funeral, this could not be carried out. It is proposed, therefore, that a medallion with a suitable inscription should be placed in the north aisle near those of Darwin and other eminent men of science that cluster round the monument of Newton. Westminster Abbey is an international institution, and it is certain that this proposal will not appeal to Englishmen alone.

It is also thought that everyone will be in favour of the erection of a sculptured monument, not a mere statue, but something which will direct attention to the nature of his achievements, in some prominent place in London which every citizen and every visitor cannot fail to see and to observe.

But it was felt that a memorial of a still more international character was desirable, and for that the committee recommended something which would combine the merits of the Nobel Prize and those of the Carnegie Trust. Under the proposed scheme the trustees of the fund would be able to devote the interest of it at their discretion either to the promotion of research bearing upon the progress of surgery, or as awards in recognition of notable advances in this science. Naturally these awards would be open to men of all nations, and this is as it should be, for Lister's work was not in any sense insular; its beneficent effects are felt in every part of the inhabited world.

We think that the decisions of the committee are wise and will meet with general approval. It is needless to say that in order to carry them out a large sum of money will be required. We are happy to hear that already several generous donations have been made, and we have great confidence that the appeal will be widely responded to. We would point out that it is not only the large gifts of the wealthy that are sought, though they are no doubt essential to the success of the scheme, but also the smaller tributes of esteem, the thank-offerings of those who recognise that every household in the land is a debtor to the great man who has passed from amongst us.

Donations should be sent to the treasurers of the Lister Memorial Fund, Royal Society, Burlington House, W.

M. LECOQ DE BOISBAUDRAN.[1]

In the death of M. Lecoq de Boisbaudran, which took place in May of the present year, there passed from the field of activity one of the most brilliant and energetic of French investigators. Lecoq de Boisbaudran was an amateur in the true sense of the word, and he had the faculty of concentrating the whole of his energy upon the question of the moment. He was born in Cognac in 1838. His parents were of noble family in Poitou, but their circumstances prevented his receiving more than an ordinary education. While a young man, he studied mathematics under his uncle, who had been a student at l'École Polytechnique, but his interest quickly became absorbed in the science of chemistry; he eventually succeeded in gaining an entrance to the laboratory of Würtz at l'École de Médecine, and it was here that he made the discovery of the element gallium.

Among his earlier contributions to science are papers on gravitation, meteorological phenomena, and also upon matters connected with agriculture; but physical chemistry and spectroscopy received the greater share of his attention. The probable existence of gallium had been foretold by Mendeléeff, who had proposed the name *eka-aluminium,* but to Lecoq de Boisbaudran belongs the honour of the discovery and the isolation of the element. In the field of spectroscopic research his name may be classed with those of Kirchhoff, Bunsen, Sir G. G. Stokes, and Sir William Crookes, as one of the founders of the science of spectrochemistry. His "Spectres Lumineux," published in 1874, was one of the most perfect works on spectroscopy at that time, and it possesses considerable value even at the present day; although limited to the visible region, the drawings are marvellously exact, and in the index wave-lengths of all the lines in the fifty-six spectra shown are given in Ångström units to one place of decimals; the labour involved in the work was enormous.

At the time when Lecoq de Boisbaudran was in the prime of his scientific activity, the chemistry of the rare earths was receiving considerable attention, Clève of Upsala, Marignac, Demarcay, Crookes and others were hard at work in that very interesting field of research, and he devoted himself with all the energy of his nature to the work; during the period from 1880 to 1900 his communications to the Academy appeared in almost every issue of the *Comptes rendus.* He was successful in discovering and isolating the elements samarium and dysprosium, and he very completely investigated the body now known as gadolinium, which had been provisionally named $Y\alpha$ by Marignac.

In his earlier investigations he depended largely upon the indications given by the *spark spectrum,* produced by passing an alternating spark between electrodes immersed in a solution of the salts, and also upon the absorption spectrum of the solution; the spectra of didymium, erbium, holmium, &c., were very fully examined by this latter method.

At the time when the work of Sir William Crookes upon the kathode phosphorescence spectrum of the rare earths was published, he made the observation that if the condensed spark from one electrode was allowed to strike upon the surface of a liquid containing a rare earth salt, there was produced, just where the discharge struck, a faint luminous spot, which, when examined with a spectroscope of low power, gave rise to a series of faintly luminous bands, closely resembling the phosphorescent bands of Crookes; this he called the *reversal* spectrum, and the method of investigation was largely used by him in his speculations upon the constitution of the yttria earths. His conclusions in this particular were in direct opposition to those of Crookes, who, as the result of an extended series of observations on the brilliant bands produced by kathode phosphorescence, had suggested that the element yttrium was composed of a number of very closely allied bodies, which he termed *meta-elements,* each producing a distinct phosphorescent spectrum. M. de Boisbaudran, on the other hand, held the opinion that yttria, when perfectly pure, did not phosphoresce under kathode rays, and that the bands observed by Crookes were due to impurities contained in the yttria.

The origin of the band-producing earths is by no means clear even at the present day, but the fact remains that although much work has been since done upon the element yttria, no one has succeeded in producing the non-phosphorescing material of Lecoq de Boisbaudran. It is a great misfortune that the numerous researches of Lecoq de Boisbaudran, particularly those referring to the rare earths, have not been collected together and published in complete form; there are probably few of the rare earth elements about which some observation could not be found under his name; but, scattered as they are in isolated papers, they are in large measure lost, and probably many of his original observations will have to be re-made by his successors. This, unfortunately, was characteristic of the man. His method was to work and publish almost simultaneously; so engrossed was he in his work that he cared little for public recognition.

The cross of the Legion of Honour was conferred upon him for his discovery of the element gallium, but he never officially received the Order.

[1] An article from the pen of M. G. Urbain upon the life and work of Lecoq de Boisbaudran appeared in the *Revue Générale des Sciences* for September 15, and to that the present writer is indebted for several particulars not otherwise available.

He was awarded the Bordin prize in 1872, and was made correspondent of the chemical section in 1878. He received the Davy Medal of the Royal Society in 1879, and the Lacaze prize in 1880.

He died, after a painful illness, on May 28, at the age of seventy-four years.

J. H. GARDINER.

NOTES.

In our issue of April 18 last (vol. lxxxix., p. 172) the announcement was made of the appointment of a Royal Commission to inquire into and report upon the natural resources of the Empire. On that occasion it was not possible to give the names of the Commissioners, but we are now able to say that the Commissioners originally appointed were as follows:—Lord Inchcape, Sir Edgar Vincent, K.C.M.G., Lieut.-Colonel Sir C. J. Owens, Sir H. Rider Haggard, Mr. T. Garnett, Mr. W. Lorimer, the Hon. G. E. Foster, Mr. D. Campbell, Sir Joseph G. Ward, Bart., Sir David Pieter de Villiers Graaf, Bart., and the Hon. E. R. Bowring. Some changes have taken place in the composition of the Commission since it was appointed, but neither originally nor now, so far as we can find, does the Commission include a single member prominently associated with some branch of scientific knowledge. This is the more surprising because it may be remembered that in March last, a month before the Royal Commission was appointed, the British Science Guild issued a report prepared by one of its committees, under the chairmanship of Sir William Ramsay, K.C.B., F.R.S., on the question of the conservation of natural sources of energy. The British Science Guild committee was composed almost entirely of expert men of science, who had given particular attention to the study of the questions with which the Royal Commission is dealing; and it is greatly to be deplored that one or more of their number, or other representatives of pure or applied science, have not been appointed members of the Commission.

The recent publication of the "Life and Scientific Work" of Prof. Tait, of Edinburgh, reviewed in NATURE of July 13, 1911, has reawakened a desire on the part of his many old students and friends to have a worthy memorial of the "great natural philosopher." The proposal is to found a second chair of natural philosophy in Edinburgh, to be called the Tait chair, and a strong appeal for contributions towards an endowment fund has been issued by a representative committee. Accompanying the appeal there is a fine tribute on Tait and his work from the pen of Prof. Peddie, of Dundee, one of Tait's former assistants. There is also an interesting statement on the need of a second chair, in which Prof. MacGregor shows that, in comparison with other universities which have approximately the same number of students, the University of Edinburgh is far behind as regards the numerical strength of its teaching staff in experimental and mathematical physics. As early as 1872, Tait himself, in an article in *Macmillan's Magazine*, lamented the understaffing of the Scottish universities, giving it as his opinion that there should be "a professor of applied mathematics in each, and a professor of experimental physics, in place of the present solitary professor of the enormous subject of natural philosophy." This is the ideal which the committee has set before it, and for the realisation of which it has appealed to a wide public. In the days of his activity Tait was a frequent and much-valued contributor to the columns of NATURE, and in the interests of the higher development of physical and mathematical science, we have much pleasure in directing the attention of our readers to this great and worthy object. The honorary treasurer of the fund is Sir George M. Paul, 16 St. Andrews Square, Edinburgh.

The dinner given by the Fishmongers' Company on October 24 to a distinguished company, "to meet the President of the Royal Society," may well be taken as an indication of the esteem in which scientific work is held by a great City company. The assembly invited included representatives of numerous branches of science, among whom were many members of the Royal Society. The following scientific societies, for instance, were represented:—The Royal Horticultural Society, the British Science Guild, the Society of Antiquaries, the Royal Astronomical Society, the Institution of Civil Engineers, the Linnean Society, the Geological Society, the Royal Microscopical Society, the Chemical Society, the Entomological Society, and the Surveyors' Institution. Sir Archibald Geikie, in responding to the toast of "The Learned Societies," proposed by the Prime Warden, said that the City guilds have played an important part in the history of London. The learned societies, too, have had close relations with the City companies. The Clothworkers' Company has had two distinguished masters who have been presidents of the Royal Society—Samuel Pepys and Lord Kelvin. The City guilds, too, have shown great diligence in the application of their funds for educational and scientific purposes.

An account of certain red bands observed by Profs. Breuil and Sollas in Bacon's Hole, on the Gower peninsula, and apparently of prehistoric origin, appeared in NATURE of October 17 (p. 195). According to *The Cambria Daily Leader* of October 18, the markings were made by a Mumbles boatman eighteen years ago, and were produced with a brush having red paint upon it, which was part of the salvage from the wreck of a Norwegian barque. Several other explanations have since been put forward, and are referred to in a short article in Tuesday's *Times*. Whether the markings are of ancient or modern origin does not appear yet to have been decided definitely, but the position of the question is shown by the following extract from *The Times* article:—"When they observed the marks the first question which presented itself to Prof. Breuil and Prof. Sollas was: 'Are they ancient or modern?' Prof. Breuil, having wetted the surface, attempted to remove the paint by vigorous rubbing; not succeeding in this, he concluded they were ancient. Prof. Sollas closely examined the wall to see whether the paint was covered by stalactite, and convinced himself that it was. To reassure himself on this point Prof. Sollas has lately revisited the cave. He was able with a hammer and chisel to detach a fragment of the painted surface from a projecting corner. This affords an excellent section through the deposits, revealing a layer of the red paint, which covers an older layer of stalactite, and is itself covered by a later layer, in some places as much as two millimetres thick. There can be no doubt that Prof. Breuil and Prof. Sollas were scrupulously exact in their observations, and as the marks resemble in general character the accepted paintings of Upper Palæolithic age, and in particular some red bands at the extremity of the great gallery in Foul de Gaume, they were amply justified—whatever the final verdict may be—in assigning the paintings of Bacon Hole to an ancient period."

THE next meeting of the Geologists' Association will be devoted to a conversazione, which will be held to-morrow (November 1), in the library of University College, Gower Street, W.C.

THE Royal Academy of Sciences of Naples is offering a prize of 20*l.* for researches on the algæ of the Bay of Naples preferably from the biological point of view. The essays, which are to be sent in by June 30, 1913, are not returned to the authors.

THE death is announced of Prof. Paul Segond, professor of surgery in the Paris Faculty of Medicine, at the age of sixty-one years. Prof. Segond was formerly chief surgeon at the Salpêtrière Hospital, and assisted in the preparation of the "Dictionary of Medicine and Practical Surgery."

The Kew Bulletin announces that Mr. I. H. Burkill, Reporter on Economic Products to the Government of India, and curator of the Industrial Section of the India Museum, Calcutta, has been appointed by the Secretary of State for the Colonies director of the Botanic Gardens, Singapore, in succession to Mr. H. N. Ridley, C.M.G., F.R.S., retired.

IT is reported in the *Revue Scientifique* that, out of the fund raised for the recent centenary celebration of the establishment of Avogadro's law, the Turin Academy of Sciences will found a prize of 1500 lire and a gold medal for the best critical, historical, or experimental work on the discoveries resulting from the law. The prize will be awarded on December 31, 1914.

THE Liverpool School of Tropical Medicine is arranging to send an expedition to Jamaica and the West Indies. The Colonial Office is cooperating with the school in this expedition, which, it is interesting to note, is the twenty-ninth made by the Liverpool authorities. The various expeditions have cost some 30,000*l.*, but on its work as a whole the school has spent more than 100,000*l.*, nearly all of which has been raised by voluntary effort.

AT the annual meeting of the Cambridge Philosophical Society, held on October 28, the following were elected for the session 1912–13:—*President*, the Master of Christ's (Dr. A. E. Shipley); *Vice-Presidents*, Prof. Hopkinson, Prof. Wood, and Prof. Pope; *Treasurer*, Prof. Hobson; *Secretaries*, Mr. A. Wood, Mr. F. A. Potts, and Mr. G. H. Hardy; *New Members of the Council*, Dr. Marshall, Mr. G. R. Mines, Rev. Dr. Barnes, and Mr. F. J. M. Stratton.

AT the statutory meeting of the Royal Society of Edinburgh, held on October 28, the office-bearers for the ensuing year were elected, as follows:—*President*, Sir William Turner, K.C.B., F.R.S.; *Vice-Presidents*, Dr. J. Horne, F.R.S., Dr. J. Burgess, Prof. T. Hudson Beare, Prof. F. O. Bower, F.R.S., Sir Thomas R. Fraser, F.R.S., and Dr. B. N. Peach, F.R.S.; *General Secretary*, Dr. C. G. Knott; *Secretaries to Ordinary Meetings*, Dr. R. Kidston, F.R.S., and Prof. A. Robinson; *Treasurer*, Mr. J. Currie; *Curator of Library and Museum*, Dr. J. S. Black; *Councillors*, Dr. R. H. Traquair, F.R.S., Prof. J. Walker, F.R.S., Sir W. S. M'Cormick, Prof. Crum Brown, F.R.S., Prof. T. H. Bryce, Mr. W. A. Carter, Mr. A. Watt, Dr. J. H. Ashworth, Prof. George A. Gibson, Prof. R. A. Sampson, F.R.S., Prof. D'Arcy W. Thompson, C.B., and Prof. E. T. Whittaker, F.R.S. It will be noticed that Dr. Knott has been elected general secretary to the society in succession to the late Prof. Chrystal. Dr. Knott served on the council of the society for the periods 1894–97, 1898–1901, 1902–05, and was appointed one of the secretaries to ordinary meetings in 1905, which office he held until his election as general secretary.

THE annual dinner of the London School of Tropical Medicine was held at Prince's Restaurant on October 23. General Sir Reginald Talbot presided, and among others present were Lord Sheffield, Sir John Anderson, Sir Francis Lovell, Colonel Alcock, Dr. Frank Heath, Mr. H. J. Read, and Prof. Simpson. Sir Ronald Ross proposed the toast of "The School," and commented on the importance of tropical sanitation and on the debt which the Empire owed to the discoveries in tropical medicine and to the work of the doctors in this connection. Sir Patrick Manson, who responded, alluded to the efforts of Mr. Joseph Chamberlain, Mr. Harcourt, and Mr. Austen Chamberlain in the cause of tropical medicine. He reviewed the work of the school, and announced that next year a research scholarship, endowed by the bequest of Lord Wandsworth, would be available. In the course of the evening the Chairman referred to the donation of 100*l.* by his Majesty the King to the funds of the school announced that morning.

IN the second part of his usual series, "Visvakarma," devoted to the collection of examples of Indian art, Dr. A. K. Coomaraswamy gives several illustrations of statues of the god Siva, chiefly from the southern part of the peninsula. The statues of Krishnaraya and his queen from North Arcot are particularly interesting. The photographs are fairly well reproduced, but scarcely possess that delicacy which appears in similar pictures in Mr. V. Smith's "History of Fine Art in India and Ceylon."

IN *Bedrock*, the new quarterly review of scientific thought, for October, Prof. A. Keith gives a careful account of our present knowledge of prehistoric man. The recent discoveries in the region of the Dordogne have shown that Neanderthal man is confined to a restricted and comparatively late date in the Pleistocene epoch, appearing for a period, and then being replaced by modern man. But anatomical and archæological evidence agrees in showing that he could not have been transformed into modern man. Work in England proves that we must go much further back in the geological record to find our ancestral form. At least in the middle of the Pleistocene period, long before Mousterian Neanderthal man in France, modern man had appeared in England. The most likely formations from which further clues are possibly to be obtained are the Pliocene and Pleistocene strata of East Anglia. In particular, care must be taken to ensure that every quarry and excavation in that region is watched, and that no remains are discarded as lacking scientific interest simply because they resemble those of modern man.

Mr. T. Sheppard, the energetic curator of the Hull Museum, continues the issue of the series of cheap interesting pamphlets descriptive of collections under his charge, or recording new discoveries in the city and its neighbourhood. Most of the relics found in the city itself belong to the latter part of the sixteenth century and the seventeenth, and it is surprising that relics of later periods are comparatively infrequent. Hull ale has been noted for many centuries, and hence tygs or loving-cups and Bellarmine jars or "Greybeards" are particularly numerous. Another of Mr. Sheppard's pamphlets discusses, with abundant details, the early Hull tobacco pipes and their makers. Among recent additions to the museum collections may be noted a fine Neolithic celt from the neighbourhood of Knaresborough, and a remarkably fearsome man-trap, used before the prohibition of such instruments of torture by an Act passed in 1827. At Bridlington a gold half-noble of Edward III. was recently discovered.

The marvellous escape of the Danish explorer, Mikkelsen, from Greenland, in July last, after nothing had been heard of him and his companion for nearly two years, will be fresh in the memory, and it will also be recalled that he recovered the journals of the lost explorer Erichsen, which had been left at Denmark Fiord. The Danish *Geografisk Tidskrift* (No. 5, 1912), therefore, appropriately publishes maps representing the results of Erichsen's surveys in 1906–8, which, among many important features, reveal the extension of Greenland much further east than was previously believed. Working from Denmark Harbour northward to 79°, the surveyors found a much-broken coast with many islands; northward of that latitude the coast-line was found somewhat more regular. The series of maps referred to not only shows the north-east of Greenland generally, but also includes various detailed maps of Denmark Harbour and other small areas in its neighbourhood.

We are indebted to Messrs. Friedländer, of Berlin, for a sale catalogue of general scientific literature (*Naturae Novitates*), and a second devoted exclusively to entomological publications (*Entomologische Litteraturblätter*).

In the report of the Museums of the Brooklyn Institute for 1911 acknowledgment is made of the extent to which their present attractiveness is due to the efforts and energy of Dr. F. A. Lucas during the period he held the chief curatorship (1904–11). When he came the collections were little more than heterogeneous accumulations, whereas they are now a model of orderly, effective, and attractive arrangement. They have, however, already outgrown the present accommodation, which is liable to destruction by fire, and the urgent need of the institution is a new and fireproof building, specially designed for the purpose it is intended to fulfil.

The Museums Journal for October devotes an article to museum guides—that is to say, living guides, in contradistinction to guide-books—in which Mr. J. H. Leonard gives the results of his experiences in that capacity at the Natural History Museum. He insists on the importance of varying the discourse according to the nature of the particular audience, and strongly deprecates the adoption of a standard curriculum for all occasions. In addition to pointing out objects of special interest, it is urged that the elimination of popular errors should be one main object of the guide. Both at Bloomsbury and South Kensington the guides appear to be highly appreciated by a considerable section of the public.

Evidence of the intimate affinity between the faunas of Central China and North America—and therefore of the essential unity of the so-called Palæarctic and Nearctic regions—continues to accumulate, the latest instance of this occurring in an article by Mr. O. Thomas in the October number of *The Annals and Magazine of Natural History*, on certain small mammals collected by Mr. G. Fenwick Owen in Kan-su and Shen-si. Among other new forms are two specimens of a black mole-like insectivore of the size of a large shrewmouse, representing a new genus (Scapanulus) more nearly allied to the American moles, Scalops and Scapanus, than any other Asiatic form. They were obtained among the mossy undergrowth of a pine-forest in Kan-su. *Scapanulus oweni*, as the species is called, has the fore feet almost as broad, relatively, as in the true moles, with rather slender claws; those of the hind foot, with the exception of the first, being but little curved. The relatively long tail is thickly haired. The teeth may apparently be classified as

$$i.\frac{2}{2},\ c.\frac{1}{1},\ p.\frac{3}{3},\ m.\frac{3}{3},$$

or numerically the same as in the Sze-chuan Neotetracus. The lower incisors are, however, very similar to those of the desmans, a feature broadly separating the genus from Scaptonyx, an allied Sze-chuan type.

Some beautiful photographs of the secondary structure of the diatom valve, taken by Mr. T. F. Smith, are reproduced in *Knowledge* for October. The structures in question, which are only visible with the finest homogeneous immersion objectives, were first discovered by Messrs. Nelson and Karop. Mr. Smith has conducted his investigations on slightly different lines; in particular he prefers to photograph the structures at the "white dot" instead of the "black dot" focus. The photographs show a general resemblance between the secondary structures of different species, although the pretty rosettes differ considerably in their arrangement. Photographs of the fibrils detached from torn valves are given.

Mr. C. B. Crampton has followed up his recent work on the vegetation of Caithness by a series of articles in *The Scottish Botanical Review*, of which a reprint has reached us. This important paper discusses in detail the geological relations of stable and migratory plant-formations. After dealing with the conceptions of the plant-formation given by various ecological writers, the author distinguishes two classes of habitats differing in the changes or successions shown by the vegetation and in the limits set to the stability attainable by this vegetation. The two classes of plant-formations, which tend to overlap and invade each other's territory owing to the migratory nature of the geological agents of surface change, are: (1) stable formations, the plant-associations of which have their centres of distribution on ground which has for a long period been comparatively stable from the geological point of view; and (2) migratory formations, the associations of which have their distribution centres in areas within the sphere of influence of the geological agents of surface change. The author works out his conceptions in detail, applying them successfully to the various types of vegetation found in this country in particular, and gives a useful bibliography of recent ecological literature.

An interesting note on the cold August and September in London is published in *Symons's Meteorological Magazine* for October. Dr. Mill states that the long record at Camden Square (N.W. London), dating from 1858, contains no instance of any previous August or September with a lower mean temperature. The mean for August, 57·9°, was 4·4° below the average, and it was the coolest August in the fifty-five years' record. In September the mean was 54·1°, or 3·6° below the average. The shade maxima records are more remarkable than the minima; in August the mean shade maximum was 66·6°. August, 1860 and 1912, are the only months of that name in which the shade temperature failed to reach 77°. In 1912 the highest recorded was 73·2°. In September the mean maximum, 62·4°, was the lowest on record for that month, and the absolute maximum, 69·4°, was the lowest recorded in any September. Dr. Mill remarks that it is of considerable interest that fifteen consecutive months with mean temperatures above the average, May, 1911, to July, 1912, should be followed by two months of unprecedentedly low temperature.

The meteorological charts of the Indian Ocean for November, issued by the Meteorological Office and by the U.S. Weather Bureau, both contain useful articles on the cyclones of the South Indian Ocean. Both are based to a great extent on the cyclone tracks compiled by the late Dr. Meldrum, of Mauritius, and his successor, published by the Meteorological Committee. The cyclone season for this part of the ocean is from November to May inclusive, but storms are occasionally met with in other months; the maximum frequency is from December to March. The majority of the storms follow parabolic tracks, and, as a rule, recurve between latitude 20° and 22° S. Broadly speaking, the storms are found to originate somewhere along the parallel of 10° S.; "thence they travel south-westward over a track that trends more and more southerly until the vertex is attained; afterwards the track recurves to the south-eastward." The Meteorological Office chart also gives very interesting details respecting the behaviour of storms in the Bay of Bengal and the Arabian Sea.

Those who are interested in the study of the geometry of the triangle will welcome the publication of a monograph of more than fifty pages by the late Prof. G. Sidler in the *Mitteilungen der naturforschenden Gesellschaft in Bern* for 1911, published this year. The original manuscript was completed in 1902, but a difficulty occurred with the figures, which were of great complexity, and the arrangements for publication were terminated by the death of the author. The manuscript, which was in the possession of Prof. Sidler's widow, has now been edited by Dr. O. Schenker.

A paper by Mr. A. Ferguson on the genesis of logarithms, in *Science Progress* for July, should prove interesting and useful reading to mathematical teachers and others. Mr. Ferguson has carefully studied Napier's "Mirifici Canonis Logarithmorum Descriptio" and other authorities, and many of the facts brought to light are little known. The paper gives in a simple and intelligible form the methods by which logarithmic tables were constructed from first principles without the use of the modern infinite series or the calculus, and it affords historical evidence in support of the modern methods of teaching the use of logarithms without assuming the definitions of negative and fractional indices.

As is well recognised, the old system of gauging the strength of concentrated radium preparations in terms of uranium, the "activity" being expressed as so many million uranium units, is practically meaningless, on account of the impossibility of comparing together the radio-activity of two elements, so different both in the character and in the intensity of the radiations they emit. The announcement by Messrs. Hopkins and Williams, Ltd., Hatton Garden, E.C., that in future their radium preparations will be sold on the basis of the actual quantities of radium they contain is therefore a step in the right direction. We understand that they measure their preparations against a standard certified by Mme. Curie to contain a definite quantity of radium bromide, and have for disposal a considerable quantity containing from 90 to 92 per cent. of radium bromide.

Since the echelon spectroscope first disclosed the complex structure of many spectral lines previously thought to be simple, the question of the exact composition of these lines has become a serious one owing to the divergent results obtained by observers working with different instruments. The green mercury line 5461×10^{-8} cm., for example, has by various observers been resolved into from seven to twenty components. The higher numbers appear from the more recent work to be due to spurious lines produced by internal reflections in the instrument or other causes. The simple method suggested by Mr. Twyman of altering the focussing, when true lines should go out of focus and spurious lines behave irregularly, seems not to have been applied by any of the earlier observers. The favourite method has been to combine two instruments giving dispersions at right angles to each other, the two producing a series of interference points. Dr. L. Janicki, of the Reichsanstalt, using two Lummer plates, one of which was slightly wedge-shaped, has recently shown in this way that the 5461 line consists of twelve components, the line previously regarded as the principal line consisting really of a group of five.

THE study of the characteristics of the motion of a train during the accelerating period has assumed an importance indicated by the fact that the actual choice of a method of traction for services of a suburban character depends upon the suitability of the tractor to work the train during the accelerating period. Prof. W. E. Dalby, in a paper read at the Institution of Mechanical Engineers on October 25, describes a useful method by means of which time-speed, time-distance, speed-distance, and energy-distance curves may be derived from a curve of tractive force expressed as a function of the velocity. A method of reducing the data obtained from a dynamometer-car record is also considered, together with the illustration, by means of a dynamical diagram, of the principles underlying the practice of braking. The accuracy of the curves deduced can be easily checked. The whole family may be drawn rapidly by means of the integraph, starting with a curve of tractive-force.

A SECOND edition of "The A.B.C. Guide to Astronomy," by Mrs. H. Periam Hawkins, has been published by Messrs. Simpkin, Marshall, Hamilton, Kent and Co., Ltd. The book has been brought up to date, and a photograph of the zodiacal light, taken by Prof. Douglass, at Flagstaff Observatory, Arizona, U.S.A., has been included as a frontispiece. The price of the little volume is 1*s.* 6*d.* net.

A CHEAP edition of Captain Mayne Reid's "The Naturalist in Siluria," has been published by the Year Book Press. The price of the volume is 2*s.* net. From his house in the Woolhope district, the author could look over the whole series of Upper Silurian rocks, from near Hereford in the north to their southern projection by Gorstley, in Gloucestershire. Many dwellers in this naturalist's paradise, as Mayne Reid called it, will welcome this reprint of his observations.

PROF. S. W. WILLISTON'S "American Permian Vertebrates," which was reviewed in NATURE of October 24, was published in 1911. There was no date on the title-page, and therefore we printed the letters "n.d." with the bibliographical particulars at the head of the notice. The manager of the Cambridge University Press now points out that at the back of the title-page it is stated that the volume was published in Chicago in October, 1911. We cannot attempt, however, to do more than give particulars from the title-pages themselves at the head of notices in our review columns.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR NOVEMBER:—

Nov. 4. 15h. 0m. Mars in conjunction with the Sun.
5. 21h. 0m. Pallas in conjunction with the Moon (Pallas 0° 26′ N.).
7. 15h. 59m. Venus in conjunction with Jupiter (Venus 1° 43′ S.).
8. 13h. 28m. Mars in conjunction with the Moon (Mars 3° 7′ N.).
10. 6h. 50m. Mercury in conjunction with the Moon (Mercury 1° 54′ N.).
11. 1h. 21m. Jupiter in conjunction with the Moon (Jupiter 5° 5′ N.).
,, 8h. 21m. Venus in conjunction with the Moon (Venus 3° 21′ N.).
13 to 15. Maximum of Leonid Meteor Shower.
14. 7h. 59m. Uranus in conjunction with the Moon (Uranus 4° 27′ N.).
19. 1h. 0m. Mercury at greatest elongation east of the Sun (22° 14′).
20. 16h. 54m. Mercury in conjunction with Jupiter (Mercury 2° 47′ S.).
22. 18h. 0m. Saturn at opposition to the Sun.
24. 3h. 47m. Saturn in conjunction with the Moon (Saturn 6° 17′ S.).
27. 20h. 49m. Neptune in conjunction with the Moon (Neptune 5° 33′ S.).

SCHAUMASSE'S COMET 1912*b*.—The identity of the comet discovered by M. Schaumasse on October 19 with Tuttle's comet, last seen in 1899, is shown by the elements for its orbit, published in Circular No. 136, from the Kiel Centralstelle, and given below in the first column:—

	1912*b* (Fayet and Schaumasse)		Tuttle's (Rahts)	
π	= 113° 50′ 20″	1912·0	= 116° 29′ 3″	1900·0
☊	= 270 23 58	1912·0	= 269 49 54	1900·0
i	= 53 52 34	1912·0	= 54 29 16	1900·0
q	= 1·0506		= 1·0191	

According to the new elements, perihelion passage took place on October 25·3153 (Paris M.T.), when the comet was some 97·6 million miles from the sun. The previously calculated time of perihelion was January 3, 1913, and thus, as a writer in *The Times* (October 24) points out, the present revolution is the shortest on record, as was also the case with the last return of Halley's comet. The difference of seventy days between the calculated and actual returns will probably be disclosed when the planetary perturbations during the last cycle are taken into account.

The ephemeris given in the Centralstelle circular indicates that the comet will not become brighter, is travelling southwards rapidly, and will not be visible in the northern hemisphere after November 23.

Ephemeris 12h. (M.T. Paris).

1912	α h. m.	δ ° ′	1912	α h. m.	δ ° ′
Oct. 30 ...	10 30·9 ...	−12 41	Nov. 7 ..	10 54·5 ...	−22 2
Nov 3 ...	10 42·6 ...	−17 25	,, 11 ...	11 6·7 ...	−28 37

GALE'S COMET 1912*a*.—A number of observations of comet 1912*a* are published in No. 4606 of the *Astronomische Nachrichten*, and a photograph by Mr. H. E. Wood at Johannesburg is reproduced. On September 13 the comet was visible to the naked eye, magnitude 5, and had an almost stellar nucleus surrounded by an even coma 4′ in diameter. The tail was fan-shaped, with an angle of about 60°, the branch to the south being 40′ long, while the south-following branch had a length of 1°. On a photograph taken with the Franklin-Adams camera, exposure 40m., the former branch is the same length, but the latter is 4° long, and slender, having a contortion 0·75° from the nucleus. On September 15 this contortion was 1·4° from the head, and the tail, $5\frac{1}{4}$° long, was clearly double $2\frac{1}{2}$° from the head.

Ephemeris 12h. M.T. Berlin.

1912	α (true) h. m.	δ (true) ° ′	log r	log Δ	Mag.
Oct. 31	16 2·1	+23 55·2			
Nov. 2	16 3·8	+25 21·6	9·9605	0·0988	7·0
4	16 5·4	+26 45·8			
6	16 7·0	+28 8·3	9·9832	0·1052	7·2
8	16 8·6	+29 29·5			
10	16 10·3	+30 49·7	0·0057	0·1105	7·3
12	16 12·0	+32 9·0			
14	16 13·7	+33 27·8	0·0280	0·1145	7·5

Dr. Ebell calculated the brightness, by the formula $1/r^2\Delta^2$, on the assumption that on September 26 the magnitude was 6·0, but Mr. Franks found it to be a little more than 4·0 on October 11, while, in a good sky, M. Gonnessiat estimated it as 5·5 for the whole comet, on September 29. There appears to be definite evidence for an intrinsic brightening while near perihelion.

The Total Solar Eclipse of October 10.—A telegram from Prof. Morize to the *Astronomische Nachrichten* (No. 4606) states that the observations of the total eclipse at Christina (Minas Geraes, Brazil) were spoiled by rain, although some selenium-cell observations of brightness were made by Dr. Ristenpart. Prof. Perrine, cabling to Prof. Pickering from Brazil, also states that rain prevented observations. A further telegram, published in No. 4607 of the same journal, announces that the eclipse was observed under favourable conditions at Quito by Señor Tufiño.

International Standard Time.—The *Revue générale des Sciences* (No. 19) gives an outline of the present state of the question of the international standardisation of time, and the programme prepared for discussion at the International Conference which met at the Paris Observatory on October 15. The acceptation by France of the international *réseau* removed the last great obstacle to the unification of standard times, and the general distribution of time-signals by wireless telegraphy makes this unification more than ever necessary. It has been found that signals sent from different stations show inconsistencies amounting to several seconds, not very serious in ordinary affairs, but fatal in matters demanding scientific precision. To remedy this state of affairs the Bureau des Longitudes invited the International Conference to reassemble in Paris, and drew up a tentative programme of the matters for discussion. Under seven main headings this programme practically exhausts the debatable points concerning the determination of time, the methods of keeping it, and of distributing it by radio-telegraphy and otherwise, the precision necessary for different purposes, and the general question of how to organise internationally in order to gain these ends.

THE ORIGIN OF LIFE.

One of the most interesting of the recent meetings of the British Association at Dundee was that devoted by the joint sections of Zoology and Botany to the discussion of the problem of the origin of life. It should be remarked that this was not a discussion of the President's address; it was arranged before the subject of the presidential address had been made known. The President (Prof. E. A. Schäfer), who occupied the chair at this meeting, explained at the outset that his address had been written and printed before he knew that this discussion was to take place.

Prof. E. A. Minchin, in opening the discussion, pointed out that the problem of the origin of life involved two inquiries, both of which were at present of a speculative order, namely: (1) the nature and characters of the earliest living beings, and (2) the manner in which the primordial form of life took origin and maintained its existence upon the earth. The first of these problems could be considered with profit, but the second, owing to the inadequacy of the data available, appeared to him to be scarcely ripe for discussion. He observed that the cell, which might be defined as an individualised mass of protoplasm containing at least one nucleus, was generally regarded as the simplest type of organism, and as the vital unit in the composition of living beings, whether plants or animals. It was improbable that the earliest forms of life came into existence as organisms composed of two distinct structural elements—the nucleus and the cytoplasm (body-protoplasm). Which of these—the cytoplasm or the nucleus—was to be regarded as representing or containing the most primitive elements of the living substance? By most biologists the cytoplasm had been considered to represent the true living substance, and the earliest living organisms—the so-called Monera—had been supposed to be formless masses of protoplasm without nuclei.

Prof. Minchin proceeded to advance reasons for believing that the chromatin substance invariably present in the nucleus, or occurring as grains (chromidia) scattered in the cytoplasm, represented the primary and essential living matter. In support of this view he pointed out that chromatin is always present in the bodies of living organisms of all kinds, that cells cannot continue to live if deprived of their nuclei, that in reproduction by fission the chromatin divides first and is distributed among the daughter-individuals, that the complex process of division of the nucleus known as karyokinesis may be regarded as a mechanism gradually evolved and perfected for ensuring an exact quantitative and qualitative partition of the chromatin between the daughter-nuclei—an indication that the chromatin is of prime importance—that the chromatin-substance plays an essential part in syngamy (fertilisation) and probably also in heredity (as carrier of the characters of the organism), that the nucleus is essential for the continuance of the secretory activities of the cell, and, finally, that in some of the minutest living organisms—*e.g.* spirochætes and the male gamete of the malaria parasite—the body appears to consist mainly or entirely of chromatin, and cytoplasmic elements are reduced to a minimum or are altogether absent. Prof. Minchin quoted from a communication received recently from a correspondent, who pointed out that the protein molecules of the nucleus are simpler in constitution than those of the cytoplasm, and therefore may be regarded as more primitive. Further, the amido-acids characteristic of the nucleus are of the open-chain order and free from complexity, while those of the cytoplasm are of the closed order and could only have arisen from the type of acids present in the nucleus. For these reasons Prof. Minchin regarded the chromatin as the primitive living substance, and held the view that the earliest forms of life were very minute particles of chromatin, round which, in the course of evolution, achromatinic substances were formed. Within the cytoplasmic envelopes thus produced the chromatin-grains increased in number, and organisms of the degree of structural complexity of a true cell arose finally by concentration of the chromatin-grains into a compact organised mass—the nucleus proper.

As regarded the origin of the earliest living beings, it was only possible to frame vague speculations, in the present state of our knowledge, concerning the chemistry of the protein compounds, on the one hand, and the metabolism and modes of life of the simplest living things on the other. He referred to the extreme view, represented by Arrhenius, that life had had no origin in finite time, but was coeval with matter and energy, and then turned to consider the view, more prevalent among biologists, that living matter had arisen at some time from that which was not living. If life arose under conditions not now existing in nature, there seemed to be no reason why such conditions could not be reproduced artificially, but if the conditions under which life arose *de novo* were not different from those existing there seemed to be no reason why it should not do so again. Why, then, did we not see new forms of life appearing on the earth? Prof. Minchin doubted if the simplest forms of life were yet known, or even if we could recognise them or be aware of their existence at their first appearance. The first origin of life involved a synthesis of protein substances in nature by some process as yet totally unknown. For light on these problems we must look to the future advance of knowledge, and especially of chemical science. In the present state of our knowledge, the attitude towards the problem of the origin of life could only be one of expectancy for more light in the future; at present it was not possible to frame a hypothesis which could have any greater value than that of a pious belief.

Mr. Harold Wager said that the more one saw of the lower forms of life, the more remote seemed to become the possibility of conceiving how life arose. He opposed Prof. Minchin's view that chromatin was the primary living substance, and in support of his contention referred to the structure of the blue-green algæ. These, he said, were interesting as the only organisms which would survive in very hot water (*e.g.* hot springs), and had been regarded as probably the last remnants of the early vegetation of this earth. Each cell of those algæ contained an irregular network of chromatin without a limiting membrane, and not clearly differentiated from the surrounding protoplasm, *i.e.* the chromatin more nearly resembled the cytoplasm in these than in higher organisms. Further, in certain bacteria there were granules of nuclear matter, but in others there were none, the organism consisting of cytoplasm only. These facts impelled Mr. Wager to regard the cytoplasm, and not the chromatin, as the fundamental life-substance.

Prof. F. W. Keeble thought that, having regard to the highly complex interacting phenomena presented by living organisms, it was improbable that the creation of "synthetic life" would be seen in the near future.

Prof. A. B. Macallum believed, with Tyndall, that matter was endowed with the potentiality of life, and to that extent he was in sympathy with the view of Arrhenius. No doubt the organism which first came into existence was ultra-microscopic, and comprised but a few molecules. The conditions necessary to produce such organisms do not now hold, but at one time the earth's surface was a vast laboratory in which syntheses of various kinds took place, and a favourable conjunction of forces produced the combination of a number of molecules in which life was. This organism would not be a cell, with cytoplasm and nucleus, but an ultra-microscopic body. The cell was as far removed from such a minute body as man is from the cell.

Prof. Benjamin Moore said that vitalism was a purely static view of life, and was untenable. Structure was important, but something more than structure was necessary for life; dynamic energy—energy, motion, change—was essential, and was manifest in all living organisms. To suppose that life began as blue-green algæ, or some such complex organism, was nonsensical. It was necessary to begin with the formation of organic molecules from the inorganic, then to build up more complex molecules (in which all the atomic combinations were saturated), and group them into colloidal substances. The colloids, which are large aggregates of molecules, show the properties of dawning life, for in presence of sunlight colloids begin to form organic bodies, but it would be necessary to add to the colloid an energy-transformer. He regarded the problem under discussion not as metaphysical, but experimental.

Prof. J. S. Macdonald regarded the problem from the point of view of a physiologist, and said he could not accept the statement that chromatin was the most important portion of the living cell, for in muscle the contractile mechanism is located in the cytoplasm, the functional activity of a red blood-cell is resident in the cytoplasm, and the main functions of the central nervous system are also associated with the cytoplasm. He held, therefore, that the nuclear material was not concerned in carrying out the main functions of the body.

Prof. Marcus Hartog referred to the power of multiplication of organisms, and said he could see no reasonable probability of our being able to create life afresh, or, indeed, to understand how it came into existence.

Prof. Patrick Geddes put forward a plea for the psychological aspect of the inquiry, for he held that even the simplest organisms presented a dawn of psycho-biosis, and that life was not merely a question of matter (*e.g.* chromatin).

Dr. J. S. Haldane said he belonged to a school which believed life could not be explained, or interpreted finally, by the known chemico-physical properties of matter, and he could not imagine any laboratory experiment, according to our present knowledge, which would bring us any nearer to the origin of life.

The Rev. T. R. R. Stebbing pointed out that for years past many evolutionists had recognised, as a necessity of the theory, that organic life must have been derived from what was inorganic, and that it was reassuring to find that this *a priori* speculation could be supported on grounds of scientific probability.

Dr. P. Chalmers Mitchell stated that in his opinion there was not a single property of protoplasm which had not its exact physical parallel, nor a single quality of life which would show there existed in life something which was not to be found in matter.

J. H. A.

THE SCIENTIFIC THEORY AND OUTSTANDING PROBLEMS OF WIRELESS TELEGRAPHY.[1]

IN opening a discussion on the present state of the theory of wireless telegraphy and its outstanding problems, I am, to some extent, embarrassed by the wide field which presents itself for consideration.

I venture to think that we may best take advantage of the simultaneous presence here of physicists, mathematicians, engineers, and electricians, if we endeavour to focus attention, in the first place, on some of the chief scientific problems which are yet unsolved in connection with it.

Perhaps a word of explanation may be offered on the reason for giving prominence to the scientific aspect of the subject rather than its practical achievements. The achievements loom large in the public eye, and are astonishing to the uninitiated, but experts in radio-telegraphy are well aware that many of the

[1] Introductory remarks by Prof. J. A. Fleming, F.R.S., at a joint discussion by Sections A and G of the British Association at Dundee.

scientific phenomena are imperfectly understood. If we are to overcome present difficulties and limitations and make fresh advances, it can only be by a thorough comprehension of the physics of wireless telegraphy. Hence it will be more to our advantage to bring combined scientific thoughts to bear upon the matters on which even leading experts differ or are ignorant, rather than let our symposium resolve itself into a discussion on apparatus or systems or the recitation of performances and the record of results.

As the only type of wireless telegraphy which has any considerable theoretical interest at the present time is that involving the application of unguided electromagnetic waves, our attention will doubtless be chiefly directed to it.

Starting from the discoveries of Hertz and his followers, we enter a new era. Apart from Marconi's improvements in the metallic filings coherer of Hughes, Branly, and Lodge, the important element in the arrangements by which in 1896 he applied purely scientific knowledge of Hertzian electric waves to practical electric waves or radio-telegraphy was the introduction of the long, nearly vertical aerial wire, as a radiator combined with a metal plate above or buried in the earth as the balancing capacity. In this wire high frequency oscillations are created; originally by using the wire itself as one electrode of an air condenser, and the earth as the other, but later on by inducing oscillations in the wire by means of the dead-beat or oscillatory discharge in another condenser circuit including a spark gap, coupled to the air-wire circuit. Although enormous ingenuity has been expended in improving or varying every element in the appliances, we can say that with the exception of a small number of stations using the Duddell-Poulsen arc generator, nearly all the practical wireless telegraphy in the world is at present (1912) conducted by the following apparatus.

At each station there is a transmitter which comprises three elements:—

1. A source of high electromotive force which may be a continuous-current dynamo and storage battery, an alternator and transformer, or a battery and induction coil giving continuous, alternating, or interrupted high-tension electromotive force.

2. A condenser in which the generator stores an electric charge to be suddenly released when a certain potential is attained across a spark gap in the form of an electric discharge passing through a coil in series with the condenser.

3. An open or radiative circuit coupled to the condenser circuit, comprising an antenna or arrangement of elevated air wires, a balancing capacity or counterpoise often buried in the earth, the two being connected through an adjustable inductance coil.

At the receiving station we have also three elements:—

1. An absorbing antenna by which the radiation from the transmitter is picked up, creating in it high-frequency oscillations.

2. A condenser circuit having variable capacity and inductance coupled to the antenna and syntonised to it.

3. Some form of oscillation detector connected in series or parallel with the above condenser which is affected by the oscillations and sets in operation a recording or indicating device which makes a visible or audible signal.

Generally speaking, at any one station the radiating and absorbing antennæ are one and the same, and used for both purposes alternately, and each station has both transmitting and receiving apparatus. The functions are, however, not identical. What is required in the transmitting antenna is a certain height and also free or insulated ends. In the receiving antenna, not only height but surface is required, although this antenna can be laid parallel with and close to the earth and earthed at both ends; but provided it is half a wave length in length, it will still absorb a considerable amount of energy from electric waves arriving in its own direction.[2]

In the next place as to exact details, the following information may be useful to those who are not wireless-telegraph engineers.

The antenna consists of a large number of hard-drawn copper wires, which are upheld by masts or towers in such fashion that the wires form a sort of fan elevated in the air; or they may rise up for a certain height and then be bent downward on all sides, like the ribs of an umbrella. In the case of our battleships, they are groups of parallel wires kept separate by wooden stars and stretched between the masts and then led downwards to the bow and stern of the ship. In the high-power Marconi stations they rise up vertically for a certain distance, and are then stretched horizontally for a distance about five times greater, parallel with the ground.

In long-distance stations the wooden or steel lattice towers or tubular masts required to sustain these wires are elaborate structures 100 to 400 feet or more in height, and have to be well stayed to resist wind.

Associated with the antenna is a counterpoise or balancing capacity, which may consist of insulated wires stretched a little way above the earth, or radiating wires or metal nets laid in the earth, or sheets or nets of metal laid on the ground, or even the metal hull of a ship.

This counterpoise is connected to the antenna through a variable inductance coil. In virtue of the capacity of the antenna with respect to the earth or the counterpoise, the whole system has a natural time period of electrical oscillation.

It may be compared with an elastic steel strip held at the bottom in a vice and loaded at the top, which can be set in vibration by small blows administered to it at the proper rate.

There are certain rates of antenna oscillation reserved for certain purposes.

Thus, for ship or coast signalling, antennæ are used having natural time periods of one-millionth or one half-millionth of a second, and for large power stations the time period may be as large as one hundred-thousandth or one fifty-thousandth of a second.

In nearly all cases these oscillations are excited in the antenna by the intermittent discharge of a condenser. They are therefore damped or decadent trains of free oscillations, separated by intervals of silence. The group frequency, as it is called, or number of the trains of oscillations, is now usually 500 to 1000, since, when using the telephone as a receiver, the group frequency is preferably that frequency for which the telephone is most sensitive. Each train of oscillations may comprise 30, 50, or 100 oscillations having the antenna frequency. The antenna is, therefore, set in electrical vibrations, so that trains of electric currents run up and down it intermittently, say, 500 times a second, each train consisting of 50 or more decadent oscillations, whilst each oscillation or single current occupies a time between one fifty-thousandth of a second and one two-millionth of a second and its complete to and fro cycle.

These high frequency currents in the antenna are created by the induction of a nearly dead-beat or else an oscillatory discharge of a condenser. In small installations the condenser is a collection of Leyden jars, or, more conveniently, glass plates coated with

[2] Numerous patents have been taken out for methods of using an antenna at the same time for sending and receiving. The inventions of Mr. Marconi in connection with this matter are both practical and important, and are being carefully developed by him.

thin sheet zinc or tin, the plates being immersed in a metal or stoneware box of oil.

In the case of some high-power stations, Mr. Marconi employs large air condensers consisting of sheets of metal hung up on insulators in a room. At Nauen and at the Eiffel Tower stations tubular or plate-glass condensers are used.

The condenser is charged by the source of electromotive force to a high potential, and then discharged across a spark gap, with or without oscillations, and this discharge passes through a coil which may be one coil of a two-coil transformer, the secondary being inserted in the circuit of the antenna, or else a single-coil transformer, then called an auto-transformer, may be made to do duty for the two separate coils in the circuits of the antenna and the storage condenser.

An important element is the spark gap. In early days when only small powers were employed, this consisted simply of two stationary brass balls. When large power first began to be applied, as at the Poldhu Station in 1901, it was soon found that the oscillatory discharge started an electric arc across the balls which had to be extinguished before the condenser could again become charged. Also the balls became rapidly worn away. To remedy these defects, various inventions were introduced. An air blast was applied to the spark gap to quench the arc.

I devised for the Marconi Co. in 1902 a discharger with revolving balls or discs driven by an electric motor which overcame some of the difficulties, and this type of slowly rotating disc discharger using low-frequency sparks was used for some considerable time at Poldhu.

Later on Mr. Marconi invented his high-speed studded disc discharger which is far more efficient, and creates a quenched musical spark of the required character. In this discharger a steel disc having studs on it revolves at a high speed between two other revolving electrodes and the passage of the studs starts a condenser discharge in which any true arc is instantly quenched. The kind of discharge required for effective work is one in which rapidly repeated, strong, highly damped discharges take place in the primary condenser circuit, and these excite prolonged trains of free oscillations in the antenna. This is only possible if any true arc discharge in the primary circuit is entirely prevented.

This is also achieved by the Wien or Telefunken, the Peukert and Von Lepel dischargers consisting of flat metal plates in close proximity. In these dischargers the discharges succeed each other with great regularity and at the rate of several hundred per second. When the condenser circuit is properly tuned to the antenna circuit and coupled to it not too strongly (with about 20 per cent. coupling), we have powerful intermittent oscillations set up in the antenna, each group being very feebly damped and of uniform oscillation frequency. These rapidly succeeding groups of oscillations are cut up into groups of groups in accordance with the signals of the Morse alphabet by means of a key placed in some part of the circuit. Although nearly all the radio-telegraphy in the world is now conducted by means of these intermittent condenser oscillations, great efforts are being made to perfect suitable high-frequency high-power alternators, and the advent of a commercial machine of this kind will no doubt make it a formidable rival to the existing methods.

Deferring for the moment the consideration of what takes place in the space between the sending and receiving antenna, we may complete our description of the receiving apparatus.

In the sending antenna we have very powerful high-frequency currents at the base and high potentials at the free or upper end. Even in small stations the sending antenna current may have a value of 5 to 10 amperes, whilst in large stations the antenna current at the earthed end is 50 to 100 amperes, and large enough to raise to incandescence quite large rods of arc light carbon.

There is, therefore, a considerable expenditure of power on the antenna. A part of this is spent in heating the antenna, but a large proportion is radiated. Nevertheless, the over-all efficiency of the usual wireless telegraph transmitter using the ordinary unquenched condenser spark, meaning by that the ratio of power radiated from the antenna to power supplied by the operating dynamo or battery, is at present probably not more than 20 per cent. to 25 per cent. in actual practice, though much higher efficiencies, even up to 75 per cent., have been claimed for the quenched-spark system. But the evidence for these high efficiencies is somewhat imperfect.

An extremely small fraction of the whole radiated energy is picked up by the receiving antenna. In this latter we have currents created which are measured in micro-amperes, or, at best, in fractions of a milliampere. If the receiving antenna is properly tuned to a closed condenser circuit inductively coupled to it, the energy picked up by the receiving antenna accumulates in the associated condenser circuit.

In this last we then have feeble currents circulating which imitate in mode of variation those of the distant transmitting antenna. To detect them, it is now most usual to employ a telephone in series with some form of current rectifier, which is shunted across the condenser in the closed secondary receiving circuit, or else some form of current-operated detector, such as Marconi's magnetic detector, which is placed in the condenser circuit.

If we merely connect a telephone across the condenser circuit, no sound will be produced in it, because the frequency of the current oscillations in the receiving condenser circuit is too high to affect a telephone. If, however, we insert some device in series with the telephone which acts like a valve, it will rectify the groups of oscillations into prolonged gushes of electricity in one direction, which, coming at the rate of the much lower spark frequency, say, about 500 or 1000 per second, create in the telephone a shrill sound. As these groups are interrupted at the sending station in accordance with the Morse signals, the receiving operator hears long or short musical sounds which he can interpret into the letters of the alphabet.

Amongst the rectifiers much used, my own oscillation valve invented in 1904, or glow-lamp detector, is an interesting example. It consists of a little electric glow lamp, having a metal plate or cylinder sealed into the glass bulb. When the filament is incandescent the space between the filament and the plate has a unidirectional conductivity, and will allow negative electricity to pass from the filament to the plate, but not in the opposite direction.

Another large class of oscillation rectifiers are the crystal and contact rectifiers, the first of which, viz carborundum, was discovered by Dunwoody, others by Pierce and Pickard. Thus, for instance, a copper point pressed against a small mass of molybdenite is a good rectifier. Also the minerals chalcopyrite, zincite, bornite, anatase, and hessite possess similar properties, and a very sensitive rectifier is made by a slight contact between two small masses of zincite and bornite. Another rectifier is the galena-plumbago rectifier. Also a gold point pressed very lightly against an artificial surface of iron pyrites (ferric disulphide) makes an excellent detector.

In spite of much valuable work done by Prof. G. W. Pierce, G. W. Pickard, and others the action of these crystal rectifiers is by no means fully elucidated. It appears not to be thermoelectric, since in general the rectified current is in the opposite direction to the thermoelectric current produced by heating the junction.

In addition to these glow-lamp and crystal rectifiers another much-used detector is Marconi's magnetic detector, in which a slowly moving band of iron wires passes across the poles of a pair of horseshoe magnets. The wire at that place is embraced by two other coils of wire—one in series with the oscillating circuit of the receiver and the other with a telephone. When trains of oscillations are set up in the receiving antenna a listener at the telephone hears a sound due to the sudden change in the magnetic state of the iron. The simplicity and absence of any difficult adjustments make this magnetic detector one of the most useful for general purposes.

The wireless message is thus picked up at the receiving station by hearing telephonic sounds due to a greater or less number of trains of high-frequency oscillations in the transmitting antenna corresponding to *dashes* or *dots* in the Morse alphabet.

These long or short groups of oscillations in the transmitting antenna create similar groups in the receiving antenna, which, when rectified, cause gushes of electricity in one direction through the telephone, and therefore make sounds like ticks or musical notes of long or short duration. The pitch of this note is the frequency of the spark at the sending station.

One of the practical difficulties not yet quite overcome is the invention of a suitably simple and sensitive *call* signal. At present the operators have to sit with the telephone on their heads waiting for any message which may begin, and this is expert work which cannot be deputed to anyone else.[3] Another requirement is a simple and yet sensitive relay by which the messages may be printed down on paper tape. The photographic method employing the Einthoven galvanometer is effective but rather elaborate.

The recently invented alternating-current resonance relay of Dr. Kapp and Mr. H. von Kramer is sensitive, and can be operated with an alternating current having a frequency of about 100, and one-fifth of a milliampere in value. What is required is a relay sensitive to currents of a frequency varying between 50 and 500 or so, and a strength of about one-tenth of a microampere.

Having thus outlined the manner in which the radio-telegraphic message is sent, I now pass on to propound for your discussion certain imperfectly solved scientific questions. The first of these is:—

By what mechanism or process are the signals conveyed across the intervening space between the transmitter and the receiver? Most persons would say, at once, by electromagnetic or Hertzian waves, produced in the æther, and the answer is no doubt correct so far as it goes. The action of the sending antenna on the receiving antenna is not merely an instance of one electric current inducing another in a secondary circuit as in the magnetic induction form of telegraphy. In radio-telegraphy the energy sent out from the sender, no doubt, departs from it entirely and exists for a time in a medium before it reaches the receiver. The question is what is that medium? The whole of the actions in the sending antenna by which the distance effect is produced are consistent with the assumption that electromagnetic waves are sent out from it. But are these waves, strictly speaking, Hertzian waves or space waves? What part, of any, does the earth play in the process? Are the very long distances which can be covered by modern radio-telegraphy consistent with the properties of pure Maxwellian or Hertzian waves produced in the æther. These are the first unsettled questions I wish to throw down for discussion. As soon as Transatlantic signals had been received by the means already described, physicists began to ask how such waves, if they are true electromagnetic waves, are propagated one-eighth of the way round the earth. Since then Mr. Marconi has achieved the feat of receiving signals in South America from his Clifden station in Ireland at a distance of 6000 miles. The problem now is to explain how this effect travels one-quarter of the way round the earth. It suggests at once the query, could it go half-way round? Can wireless signals be received in New Zealand from England, and may we look forward not merely to Transatlantic or Transpacific, but to transterrestrial wireless telegraphy to the Antipodes as a practical possibility? The answer to these questions is necessarily connected with that to the more general question, how does the sending antenna affect the receiving antenna at any distance? In a year or more, when the Imperial wireless scheme comes into operation and the long-distance stations are completed, London will speak to Aden; Aden to Bangalore and Pretoria; Bangalore to Singapore; and thence the step will be easy to Australia and New Zealand. It is possible that we may yet communicate from London direct to Melbourne without the intermediate stations. In text-books and lectures it has been usual, for the sake of simplicity, to treat the problem of radio-telegraphy as if the earth were a perfectly conducting sphere immersed in free æther. A very little practical experience showed wireless telegraphists that the electric condition of the atmosphere greatly affected it, and that the receiving apparatus, so sensitive to waves intelligently sent out from transmitting stations, picked up in addition all manner of vagrant waves set going by atmospheric discharges. Also early attempts at long-distance radio-telegraphy led Marconi to the discovery of the great influence of daylight upon the distances attainable. If, however, we leave out of account for the present these atmospheric and daylight disturbances, to which we shall return presently, we have still to face the fact that the nature of the terrestrial surface between the sending and receiving station affects the result very appreciably.

Very early in the practical experience of radio-telegraphy it was found that it could be conducted more easily over sea than over land, and more easily over ordinary wet soil than over very dry sandy soil.

But apart altogether from this last effect, it has always been felt that there was something surprising in the fact that it is possible to detect electromagnetic waves created at a distance of one-eighth to one-quarter of the way round the world. It has been generally assumed that this was wholly due to an abnormally large diffraction effect. The first question of importance is, then, whether diffraction can occur to an extent sufficient to account for the observed facts. The determining factor as regards diffraction is the ratio of wave length to the earth's diameter.

In the early attempts at long-distance wireless telegraphy wave lengths of 2000 to 3000 ft. were used, but at the present time wave lengths from 10,000 to 20,000 ft. are employed, or, say, one-thousandth of the earth's radius.

Consider for one moment an optical analogue. The mean wave length of visible light is about 1/50,000th of an inch. Suppose a luminous point of infinitely small magnitude were placed at the pole on the surface of a smooth sphere a quarter of an inch in diameter or about the size of a pea, in a region otherwise not illuminated. This corresponds to the case of electric waves 1000 metres in wave length sent out from a

[3] The Marconi Co have recently introduced a call instrument, in which a signal equivalent to a prolonged *dash* on the Morse code deflects a galvanometer, which in turn closes a bell-battery circuit and rings a bell. The difficulty is, however, to prevent atmospheric discharges from making a false call, but render it sensitive only to a prearranged signal.

radio-telegraphic station on the earth's surface. Would there be any light due to diffraction at the equator or even at 45° latitude of this small sphere? It is essentially the province of the mathematical physicists to give us a solution of the above question, but the answer would, I think, be in the negative. To make the case comparable with that of the longest electric waves used for terrestrial radio-telegraphy, the sphere would have to be only the millimetre in diameter. The answer is then not quite so obvious.

The first attempt at the problem in the case of radio-telegraphic waves was made by Prof. H. M. Macdonald in 1903 and 1904.

Last year he published a second paper in the Transactions of the Royal Society on the same subject. In this last paper a table is given for waves of two wave lengths, viz., 0·2 mile and 0·25 mile, showing the ratio of the calculated amplitude of the received oscillations at a point at certain distances measured along a great circle of the earth to the amplitude which would exist if the earth were absent. For the two wave lengths, and for a distance of 651 miles, the ratios are respectively 0·06 and 0·07, or, say, 1 : 14. It may be remarked, however, that the wave length now used at Marconi's Clifden station in Ireland is nearly four miles, and that the maximum distance at which signals have been received is 6000, and not 600 miles. Hence, before Prof. Macdonald's table can be brought into comparison with the latest practice, his wave lengths must be increased twenty times, and his maximum distance ten times.[4]

In this second paper he refers to the previously published 1904 paper, in which he showed that the effect at a point on a perfectly conducting sphere due to a Hertzian oscillator near its surface was negligible in comparison with the effect which would have been produced at that point if the sphere were removed, when the point is at some distance from the oscillator, and the radius of the sphere is large compared with the wave length.

The same problem has also been discussed by Prof. H. Poincaré, whose recent decease we have so greatly to deplore, in a series of interesting lectures and papers.[5] In his latest memoir on the diffraction of Hertzian waves in the *Jahrbuch der Drahtlosen Telegraphie* for 1910, p. 445, Prof. Poincaré reaches the conclusion that the amplitude of the oscillations at a point on the earth's surface, which is separated from a transmitting station by an angle ϕ measured along a great circle through the stations, is proportional to an exponential function $\epsilon^{-m\omega^{\frac{\phi}{3}}}$ where m is some numerical constant and ω is a complex quantity the real part of which is proportional to the frequency. This at any rate agrees with one result of practical experience, viz. that to effect radio-telegraphy over long distances large wave lengths are necessary. But it is difficult to extract from his conclusions means to enable us to predict the exact extent to which diffraction really exists for waves two to four miles in length.

The problem of the bending of electric waves round the earth has also been discussed by Dr. J. W. Nicholson in a series of able and critical papers.[6]

The conclusion arrived at by him after considering the work of Macdonald and Poincaré as the result of his own analysis can best be expressed in his own words (see *Phil. Mag.*, vol. xix., pp. 277–278, 1910).

He assumes that an oscillator is placed near the surface of the sphere with its axis radial, and he says: "On the confines of the geometrical shadow within a cone of small angle cutting off but a small portion of the terrestrial surface near the oscillator true diffraction bands are found, arising from terms now important in which the order and arguments are nearly equal. But within the shadow beyond the extreme generators of the cone, the extinction of the waves is very complete." "The harmonics of a high order are found to be so disposed as to neutralise one another in a remarkable way, and the intensity of the diffracted light at a distance of a few thousand miles round the surface sinks to a minute fraction of its value when the sphere is absent. Thus, it is improbable that diffraction can explain the effects unassisted by reflection from an ionised layer in the upper atmosphere, or by some other cause.

If this result is confirmed for wave lengths of four miles, or one-thousandth part of the earth's mean radius, then it will follow that ordinary diffraction is incapable of explaining long-distance radio-telegraphy, and we must look to some other cause. Before discussing the alternative which has been suggested both by Prof. Poincaré and Dr. Nicholson, I should like to direct your attention to an explanation of a quite different nature due to Prof. A. Sommerfeld, of Munich. Mathematicians who have dealt with the problem under the assumption of a perfectly conducting earth and a Hertzian oscillator entirely disconnected from it have assumed conditions which do not hold good in practice. Hence the attempt to explain long-distance radio-telegraphy by the aid of diffraction may be a quite unnecessary effort. The actual earth has a crust composed of materials which chiefly owe their conductivity to water. When free from water these materials composing the igneous and sedimentary rocks (apart from metallic veins and oxides and sulphides of heavy metals), such as granite, gneiss, quartz, slate, chalk, and sandstone are very fairly good insulators. Although sea water is a conductor, it has a dielectric constant ($K = 80$) very far from infinite. Moreover, at no very great depth in the crust the temperature is sufficiently high to exclude the presence of liquid water, and therefore of any conduction due to it.

The numerical values which have been given for the materials composing the earth's crust are only very approximate. Experimentalists have mostly measured the resistance and dielectric constant of dry samples with continuous or direct currents. They have omitted to take account of the fact that non-metallic materials, such as quartz, felspar, mica, slate, &c., increase in conductivity with rise of temperature and also have a conductivity for alternating currents quite different from that for direct currents.

In the majority of cases these rocky materials are very good insulators. Thus dry granite has a dielectric constant about 7 to 8 and a specific resistance which may be as high as one thousand megohms per centimetre cube, and dry slate has a dielectric constant of about 12 and specific resistance of about 500 megohms per centimetre cube.[7]

[4] See H. M. Macdonald, Proc. Roy. Soc. London, vol. lxxi., A, p. 251, 1903; vol. lxxii. A, p. 59, 1904. The conclusions in the first paper were subjected to some criticism by Lord Rayleigh and Prof. Poincaré.

See Prof. H. M. Macdonald, "On the Diffraction of Electric Waves Round a Perfectly Reflecting Obstacle," Trans. Roy. Soc. London, 1910, vol. ccx., A, p. 113.

[5] See Prof. H. Poincaré, "La Lumière Électrique," vol. iv., 1908, p. 323, December 12. Also *Comptes rendus*, April 29, 1909, and *Jahrbuch der Drahtlosen Telegraphie*, vol. iii., p. 445, 1910.

[6] See Dr. J. W. Nicholson, *Phil. Mag.*, 1910, 6th ser., vol. xix., pp. 276, 516, 757.

[7] See "Dielektrizitatskonstante und Leitfähigkeit der Gesteine," by Heinrich Lowy (see *Annalen der Physik*, vol. xxxvi., p. 125, 1911, for a number of measurements of the dielectric constants and conductivity of earth's crust materials).

It has been shown recently in a paper by the present writer, assisted by Mr. Dyke, that the alternating current conductivity of insulators is a function of the frequency, and not by any means identical with the direct current conductivity, see Journ. Inst. Elect. Eng., 1912, "On the power factor and conductivity of dielectrics for alternating electric currents." In the case of such substances as marble, slate, and probably others, the conductivity appears to increase with the frequency up to a certain point and then diminish again.

The problem of the propagation of electric waves over the earth's surface involves, therefore, three important factors which greatly influence the result, first the imperfect conductivity and rather high dielectric constant of the earth, making it a semi-dielectric. Secondly, the effects of atmospheric ionisation, natural electrification, and sunlight, and, thirdly, the earth's curvature. The German mathematical physicists have of late years considered the first of these factors very carefully, and arrived at some interesting results, which I will endeavour to epitomise. Prof. A. Sommerfeld published in 1909 a very able paper on the propagation of the waves in wireless telegraphy over the earth's surface.[8]

He supposes that a small Hertzian oscillator is placed with axis vertical at the flat boundary surface of two media, each having conductivity σ, dielectric constant K, and permeability μ, and that the bounding surface is plane and indefinite. Taking E as the electric force and H as magnetic force, we have at any point in space the two circuital or Maxwellian equations fulfilled, viz.:—

$$K\dot{E}+4\pi\sigma E=c \text{ curl } H$$
$$-\mu\dot{H}=c \text{ curl } E.$$

where $c=3\times10^{10}$. The quantities E, σ and K are measured in electrostatic units and μ and H in electromagnetic. Hence, if E and H are both simple harmonic quantities of frequency n varying as the real part of ϵ^{-jpt}, where $p=2\pi n$, and if we write

$$k^2=\frac{\mu K p^2+jp4\pi\sigma\mu}{c^2},$$

we have
$$k^2H=\text{curl}^2 H,$$
$$k^2E=\text{curl}^2 E.$$

If we then take the magnetic force to be the curl of a vector potential Π and bear in mind that for vector fields with no divergence the operator

$$-\text{curl}^2=\Delta^2=\left(\frac{\delta^2}{\delta x^2}+\frac{\delta^2}{\delta y^2}+\frac{\delta^2}{\delta z^2}\right),$$

we see that Π satisfies the differential equation

$$\Delta^2\Pi+k^2\Pi=0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and that
$$H=\text{curl } \Pi, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and
$$E=\frac{c}{4\pi\sigma-ipK}\Delta^2\pi. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If $r^2=x^2+y^2+z^2$, then a particular solution of (1) is

$$\Pi=\frac{1}{r}\epsilon^{jkr}.$$

To obtain a solution applicable to the case in question, we have to satisfy the boundary conditions.

These conditions are that the horizontal component of the electric force and the vertical component of the magnetic flux or induction must be continuous across the boundary. Taking suffixes 1 and 2 for the air and earth regions, these boundary conditions are

$$\Pi_1=\Pi_2\frac{\mu_1}{k_1^2}\frac{\delta\Pi_1}{\delta z}=\frac{\mu_2}{k_2^2}\frac{\delta\Pi_2}{\delta z}.$$

Sommerfeld then shows that a solution of the equation (1) is

$$\Pi=CJ_0(\lambda r)\epsilon^{\sqrt{\lambda^2-k^2}z},$$

where $r^2=x^2+y^2+z^2$ and λ is an arbitrary parameter, and $J_0(\lambda r)$ is a Bessel's function of zeroth degree.

By a series of difficult transformations, the validity of which must be tested by our pure mathematicians. Sommerfeld then proves that π can be expressed as the sum of three quantities P and Q such that

$$\Pi=P+Q_1+Q_2,$$

where the quantities Q_1 and Q_2 correspond to space waves (Raumwellen), and P to a surface wave (Oberflächenwellen).

It is, of course, not new to suggest that the waves involved in radio-telegraphy resemble electric waves on wires or are surface waves. It was long ago surmised that the sending antenna, the earth, and the receiving antenna might be regarded as one single oscillator in which oscillations were set up. This view has been held, amongst others, by A. Blondel, E Lecher, and F. G. Baily.[9]

Prof. Baily pointed out in 1903 that the energy of surface waves would decrease only inversely as the distance, and therefore at large distances survive when space waves would have vanished. The strict mathematical proof of their possibility has, however, only been lately given.

The space waves are subject to diffraction, and are hindered by obstacles. On the other hand, the surface waves pass round, and are unhindered, apart from damping, by the curvature of the surface. Also, owing to the surface waves decreasing in amplitude less fast with distance, the surface waves survive when the space waves are extinguished. If, then, Sommerfeld's investigation is valid, we need no longer seek for an explanation of such achievements as the detection of electromagnetic waves one-quarter of the way round the earth in any abnormal diffraction. If Sommerfeld is right, diffraction has nothing to do with the matter. The effect at such distances is entirely due to these "Oberflächenwellen," or surface waves, which, like electric waves or wires, are propagated along the surface, no matter what the curvature may be. There is a certain analogy between these space and surface electric waves, and corresponding effects in the case of earthquakes. From the time of Poisson it has been known that a shock communicated to an elastic solid created in it two waves, one of dilatation and one of distorsion, travelling at different speeds through the mass.

In 1885, Lord Rayleigh showed that, in addition, there was a surface wave dependent on the fact that the surface can be distorted and resists distorsion with a different elasticity to that of the interior of the mass.

These effects are recognised by seismologists as represented in the preliminary tremors and main shock in an earthquake.

In this case, two kinds of disturbance are found to be propagated through the earth, with velocities of 10 and 5 km. per second respectively. Also another main shock arrives later, which moves with a speed of about 3 km. per second. The latter is a surface wave travelling along the surface crust of the earth, and the two former are space waves travelling through the mass.

In the same manner we can say that in wireless telegraphy we are concerned with three waves—one travelling through the air above the earth, the second through the crust of the earth, and the third a surface or cylindrical wave, which is confined to a limited region at the boundary of the two dielectrics.

It is suggested, however, that long-distance radiotelegraphy is chiefly effected by means of the surface waves or "Oberflächenwellen" of Sommerfeld, which fall off in amplitude inversely as the square root of the distance and are not limited by diffraction as they follow round the surface. The earth's curvature

[8] "Ueber die Ausbreitung der Wellen in der drahtlosen Telegraphie," *Annalen der Physik*, vol. xxviii., p. 665, 1909.

[9] See A. Blondel, *Comptes Rendus du Congrès de Nantes*, 1898; also E. Lecher, *Physik. Zeitschr.*, vol. iii., p. 273, 1901, and Prof. F. G. Baily, Trans. Royal Scottish Society of Arts, February 9, 1903.

limits the range of the space waves seriously but does not so limit the surface waves.

One difficulty in reading Sommerfeld's paper is that he does not sufficiently translate his mathematical analysis into physical concepts. Hence it is desirable to consider a little in general terms how these surface waves arise.

(*To be continued.*)

MODERN PROBLEMS RELATING TO THE ANTIQUITY OF MAN.[1]

ON my bookshelves there is placed a series of old volumes containing past reports of this Association, which fortune sent my way many years ago on a Whitechapel bookstall. Among them there is one volume I prize—that which contains the history of the meeting at Aberdeen in 1859. In that volume you will find an early phase of the subject of my discourse for this evening—the antiquity of man. Sir Chas. Lyell presided over the section of Geology; in his opening address he announced that "a work will very shortly appear by Mr. Charles Darwin—the result of twenty years' observation and experiment," and that the evidence which had accumulated in recent years "made it probable that man was old enough to have co-existed at least with the Siberian mammoth." From other statements made in his address it is clear that Lyell was then convinced that man's appearance on earth was infinitely older than the limits fixed by Biblical record. I do not suppose I have a single listener who heard that address in Aberdeen sixty-three years ago, but even those who are not yet old will concede that the new doctrine, preached so moderately by Sir Charles Lyell, was not likely to be acceptable to the general membership of the Geological Section in the year 1859. You will find an exact record of what happened at the meeting—not in the official report of the year, but in the letters of Mr. William Pengelly, the explorer of Kent's Cavern. Orthodoxy was represented at the meeting by the Rev. Dr. Anderson, who, in Mr. Pengelly's words, "attempted to castigate Lyell for his opening address. There was a considerable amount of orthodoxy in the room, and Dr. Anderson got a very undue share of applause." The doctrine which Lyell and his companions championed in the face of public opprobrium in 1859 is the accepted and orthodox opinion of the vast majority of thoughtful people in the year 1912.

That splendid movement of the nineteenth century which knocked the shackles of tradition from the problems of man's origin was led by men of courage, conviction, and sound judgment. It was a progressive and victorious movement they initiated, but in every movement of that kind there comes a time when those who cleared the way turn circumspect, cautious, and more critical than constructive. Opinion tends to become fixed and conventionalised, and then a new heterodoxy raises its head. That is the phase which we, who make a special study of the facts relating to man's origin, seem to have reached now. I cannot cite a more stalwart or distinguished representative of the orthodox opinion of to-day than Prof. Boyd Dawkins, of Manchester. In his Huxley lecture in 1910 he gives very clearly his opinions on the antiquity of man—ripe convictions which are founded on a lifetime of active investigation and study. In his opinion the history of man does not extend beyond the Pleistocene period—the phase of the earth's history which immediately precedes the one in which we live. He accepts the fossil man of Java—Pithecanthropus—a being with a brain a little more than half the size of a modern man's, as representative of mankind at the beginning of the Pleistocene; before the end of that period men of the modern type appeared. In Prof. Boyd Dawkins's opinion, then, man was evolved during the Pleistocene period, and, therefore, from a geologist's point of view, is a recent addition to the earth's fauna. If we ask how long ago it is since man appeared, Prof. Boyd Dawkins replies: "It cannot be measured in years—only by the sequence of geological events and by the changes in animal life." Yet we are certain that years came cycling round in the Pleistocene period just as they do now, and that every cycle wrought some degree of change on the face of the earth and on the form of living things—a degree of change which may be imperceptible in the period of a man's life, and yet cumulative and apparent in the course of time. Men who have studied the transformations effected during the Pleistocene period have formed varying estimates of its duration, but we may safely adopt as a moderate figure the 400,000 years given by Prof. Sollas at a meeting of this Association in 1900. We may accept, then, as the orthodox opinion of to-day that the dawn of the very earliest form of humanity lies 400,000 years behind us; in that space of time man as we know him now was evolved from a crude, almost prehuman form.

For a representative of modern heterodoxy—as far as relates to the antiquity of man—we cannot do better than visit the Royal Natural History Museum in Brussels and follow the guidance of M. Rutot, who has devoted himself to the study of the stone implements of ancient man, and of recent geological formations. One civilisation succeeded another in Pleistocene as in historical times. You will admit, when you examine the handiwork of the men of the Magdalenian age—at the close of the Pleistocene—that our ancestors were then artistic and skilled workmen; as we pass backwards in time from the Magdalenian to the Solutrean, and from the Solutrean to the Mousterian, Mousterian to Acheulean, and Acheulean to the Chellean—thus passing well beyond the mid-point of the Pleistocene—that although the handiwork of man changes in form and in design, it does not lose in skill of execution; those flints of the remote Chellean period assure us that man had then a capable brain and a skilled hand. When, however, M. Rutot proceeds to show us the implements which were fashioned by men in the earlier parts of the Pleistocene, it is very probable that our orthodox companions will pull out their watches and find they have pressing engagements elsewhere. Human workmanship becomes cruder as we approach the commencement of the Pleistocene. The stones which have been wrought by man's hand (eoliths) become then more difficult to distinguish from those which have been shaped by natural forces. M. Rutot, however, is convinced that he has traced man, by means of his Eolithic culture, not only to the commencement of the Pleistocene, but into and through the two long geological periods which preceded the Pleistocene—the Pliocene and Miocene—and even well into the formations of the still older period, the Oligocene. In M. Rutot's opinion the origin of mankind must be assigned to a time as early as the Oligocene period. Prof. Sollas has made a provisional estimate of 900,000 years for the Pliocene and 1,800,000 for the Miocene. On this crude estimate the heterodox opinion as to the antiquity of man must be placed at more than 3,000,000 years. It is only just to M. Rutot to state that he would by no means agree with the estimates given by Prof. Sollas. In his opinion

[1] Discourse delivered before the British Association at Dundee on September 9 by Prof. Arthur Keith.

the duration of the Pleistocene period was not more than 139,000 years.

The modern heterodox movement, which I have sought to bring before you in the person of M. Rutot, had as its pioneer the late Prof. Prestwich—a geologist whose long experience and great knowledge were tempered with a sound and conservative judgment. In 1869 he found flints on the uplands of Kent, between the Thames and the Weald, which he recognised as certainly the handiwork of man. Thousands of these eoliths have been collected by Mr. Benjamin Harrison.[2] The deposits in which these eoliths are found were assigned by Prof. Prestwich to a Pliocene date. Fifty years ago Sir Charles Lyell expressed the opinion that "signs of man's existence" would be found in the Cromer beds of East Anglia, which mark the commencement of the Pleistocene period in England. Eoliths have been found not only in the Cromer beds, but also in the Pliocene formations of that district—in the Norwich Crags by Mr. Clarke, and under the Red Crag by my friend Mr. Reid Moir. Thus in England heterodox opinion traces man to the commencement of the Pliocene period. I need only add that eoliths, as evidence of man's existence, are rejected by many whose opinion is entitled to our respect. The usually accepted opinion, then, is that man makes his appearance in a definitely human form about the commencement of the Pleistocene period; there are also those who refer his evolution to a much earlier period of geological history.

One thing is certain, whatever period is adopted, the time must be long enough to allow mankind to be distributed and differentiated as we now see it in the world of to-day. Modern human races, white and yellow, red, black or brown, although so different on the surface, are yet so similar in their structure and constitution that we must suppose all of them to have arisen from a common stock. Let us look at the problem in a concrete form. I will take as opposite and contrasted types of modern humanity the fair-haired, white-skinned, round-headed European, and the woolly-haired, black-skinned negro of Central Africa, and set them side by side and study them from a purely zoological point of view. We must admit that both are highly specialised types; neither represents the ancestral form. Now, in seeking for the ancestral form of our breeds of dogs, of horses, or of cattle, we select one of a generalised and ancient type—such as we conceive might have been modified to produce modern breeds. We must apply the same system to human races. If we search the present world for the type of man who is most likely to serve as a common ancestor for both negro and European we find the nearest approach to the object of our search in the aboriginal Australian. He is an ancient and generalised type of humanity; he is not the direct ancestor of either negro or European, but he has apparently retained to a greater degree than any other living race the characters of that common stock from which both European and negro arose.

If, then, we accept the Australian native as the nearest approach to the common ancestor of modern mankind—and it must be admitted that it is not a low form of man we are postulating as a common ancestor—can we form any conception of the length of time which would be required to produce the African and the European from this common stock? What do we know of the rate at which mankind evolves? There is the classical instance of Egypt. During his residence in that country Prof. Elliot Smith and his colleagues—Dr. Wood Jones and Dr. Derry—had opportunities of examining the remains of Egyptians belonging to every period—from pre-dynastic times to the present day. They had thus facilities for studying the evolution of a people over a period of at least 6000 years—probably longer. They found evidence of an infiltration of foreign blood both from the north and from the south; they noted minor alterations in the configuration of the head and in the state of the teeth and jaws, but they could not say that the men at the end of that period were in any respect a higher or more specialised type than the inhabitants of the Nile Valley at the beginning of that period.

There is no need to go beyond our own country to find evidence that the evolution of man proceeds at a slow rate. We have now material enough to form a fairly accurate conception of the physical condition of the people who lived in Britain these 4000 years past. Were the prehistoric Britons to come amongst us now, dressed in our modern garb, they would pass unnoticed as fellow-citizens. The Neolithic men of France, Switzerland, and Germany were not in any wise a lower race than their successors of to-day. When we pass to examine human remains belonging to more remote periods, we are confirmed in our belief that the evolution of human races is a slow process. In this country there have been found at Galley Hill, at Bury St. Edmunds, and at Ipswich human remains which belong at least to the middle part of the Pleistocene period. These remains indicate a kind of man somewhat different from ourselves, but yet of the same type. In size of brain and in complete adaptation to an upright posture, they cannot be described as less highly evolved than we are.

Such evidence as we have, then, leads us to believe that the evolution of a new and distinct variety of mankind requires an extremely long period of time.

If we again ask: How long will it take to evolve the African, on the one hand, and the European, on the other, from a common stock?—Australoid, we suppose, in form—it is very apparent, on our present knowledge, we must make a very considerable allowance of time. My own opinion is that the whole length of the Pleistocene—a period, we shall say, of 400,000 years—is not more than sufficient. I am thus postulating, in order to explain the differentiation and distribution of modern races, that mankind, at the beginning of the Pleistocene period, had reached a physical condition which has its best modern representation in the aborigines of Australia.

Is it not possible, however, that the evolution of man's body may not be a story of slow, continuous, almost imperceptible change, but one of alternate spurt and quiescence? The human body is notoriously the subject of sport, of defects, and malformations. Many of you will recall the book which Prof. Bateson published eighteen years ago entitled "Material for the Study of Variation." The work contained many facts which seemed to indicate that the animal body was subject to violent structural changes, and that a new form of being might be produced almost at a bound. We often see men in whom there is an extra vertebra in the loins, an additional rib, or a supernumerary digit, but we now recognise that these marked structural changes are merely the extreme manifestations of a normal degree of variation of which every man's body is the subject. The bodies of men and anthropoids are notoriously liable to anatomical variation, and we are justified for that reason in regarding their bodies as particularly plastic material in the hands of evolution. When, however, we come to examine the anatomical differences which separate one race of men from another, we see that racial characters comprise, not those

[2] Mr. Harrison has informed the lecturer he first found those primitive flints in 1865.

marked variations which so frequently are seen by the students of human anatomy, but a multitude of minor structural features such as might slowly accumulate in the course of the differentiation of one race from another.

When one comes to realise the extremely complex structure and finely adjusted nature of the human brain, it becomes very apparent that any addition to the most essential structure of the human body must be the result of an extremely slow process of growth. Only one line of evidence shakes our belief in the slow rate of human evolution, and that is the study of certain diseases of growth to which man is liable. We have come to realise in recent years that we are, as regards face, figure, stature, and nature, largely what our internal glands and secretions have made us. Growth itself is definitely regulated by means of substances set free by certain glands of the body. We are absolutely certain that a marked disturbance of these glands will, in the course of a few years, definitely transfigure the individual to which they belong. Nature seems to have at her command a means for executing rapid advances, but when we survey what we know of man's past history, and mark the changes he is subject to in the present, we see no sign of her having resorted to such a means.

There is another route by which we may approach the problem of man's antiquity. Man does not stand alone—he has distant and rather despised relations—the great anthropoid apes. Although the structural hiatus between him and them is wide, yet when we compare the two types we see that there is a multitude of resemblances, so intimate and so peculiar that we cannot explain them except by supposing that man and the great anthropoids had a common ancestor at one stage of the earth's history. The great anthropoids have also a distant and primitive living relative—the gibbon. The gibbon, in turn, while foreshadowing in his body the structural peculiarities of his more august relatives, finds his cousins by descent in more lowly forms still—the monkeys of the Old World and the monkeys of the New. Of these two groups the monkeys of the New World are the nearest to the original stock which gave rise to the higher primates. It was through such a lineage that man rose to reach his present estate.

If, then, we are to ascertain the approximate date—or, to put it in other words, the possible date—at which man appeared, we must first search for the earliest traces of the basal forms of the higher primates which lead towards the human line. The earliest traces we have discovered as yet were described by Dr. Max Schlosser only two years ago. In the very oldest Oligocene formation of the Fayoum, Egypt, the teeth and jaws of three primates were discovered. Two of these are allied to the South American apes, the other is a forerunner of the gibbons. These Fayoum fossils are of the highest importance to the solution of our problem. Their discovery assures us that at such an early date in the evolution of mammals the South American apes and pro-gibbons were already in existence. They are highly evolved forms, and it is not unlikely that they appeared at a much earlier date. In European strata of the period following the Oligocene—the Miocene—many teeth and jaws of a form of gibbon, which differ only in slight and trivial details from the teeth of living gibbons, have been discovered during the past fifty years.

Here, then, we have the assurance that an animal which springs closely from the stock giving rise to man has come down to us with but little change through the leagues of time marked by the Miocene, Pliocene, and Pleistocene formations. By the middle of the Miocene we know the great anthropoids were in existence; it is most unlikely that the traces we have discovered mark their first appearance. With the evolution of the great anthropoids the appearance of a human ancestry as a separate stock is possible. From every point of view it is most probable that the human stock became differentiated at the same time as the great anthropoids. On the evidence afforded by our very imperfect knowledge of fossil forms of apes, we are justified in assuming that a very primitive form of man may have come into existence during the Miocene period—at the very latest during the early part of the Pliocene. Thus when we pursue the question of man's antiquity by studying the forms of primates contained in the Tertiary strata, we find reason to extend the possible date of his origin at least a geological epoch beyond what is allowed by the strictly orthodox. We are unable, however, to find evidence in support of the more extravagant claims of the ultra-heterodox represented by M. Rutot.

There is still another and a very important line of evidence bearing on the antiquity of man. We have, in the most cursory manner, followed the evolution of various ancestral forms of ape and anthropoid from the past towards the present; I propose now to follow the history of man's evolution, so far as we yet know it, from the present into the geological past. We are all evolutionists nowadays, and it is but natural that every one of us should expect man to become more anthropoid and more brutal the further we trace him into the past. What have we found? At the close of the Pleistocene period, which even orthodox and conservative geologists admit to have come to an end some 15,000 years ago, the men of Europe in stature and in size of brain were at least our equals. In tooth, limb, and bone they were more robust. When, however, we turn our eyes to France and pass backwards in the Pleistocene to the epoch marked by the last or fourth of the cold cycles which subdivided that period, modern man disappears; his place is taken by a human being of an altogether different kind—a human race or species to which the name of Neanderthal has been given by international consent.

During the last six years, thanks to the enthusiasm, industry, and genius of French anthropologists, the remains of four individuals of this race have been unearthed. The strata in which these remains were found contain stone implements of the type known as Mousterian, and of animals belonging to a cold climate. Neanderthal man appears suddenly in this later part of the Pleistocene, and as suddenly disappears, to be replaced by modern man. It is impossible to conceive that, just at the close of the Pleistocene period, Neanderthal man was suddenly converted into modern man. Think for a minute of the interpretation you would give of the Australian strata that are being laid down now. The older deposits contain the remains of aborigines, the newer Europeans. You do not suppose that the aborigines are suddenly transformed to European. You must apply the same interpretation to the human remains found in the later Pleistocene. There was a supersession, not a transformation of races. We must infer, then, that at the end of the Pleistocene period there were two distinct races of mankind—Neanderthal and modern. That is a fact which our French colleagues seem to grasp with difficulty.

To follow the history of modern man into the past we shall return to England. It is a mystery why Neanderthal remains have not been discovered in England; they ought to be found, and a rumour is now current that they have been found. The oldest remains so far unearthed in England all belong to the modern type of man. They take us a long way further into the Pleistocene than the era of Neanderthal man. The skull fragment known as the Bury St. Edmunds was found in strata containing Acheulean flints and remains of the mammoth; the 90-ft. terrace of the Thames, in which the Galley Hill man was found, contains flints of the Chellean type. The Acheulean and Chellean flint civilisations are attributed by Prof. Boule—a most trustworthy authority—to the long temperate interval which lies between the two last of the glacial cycles of the Pleistocene, or, if we accept the evidence of Prof. Penck, between the second and third cycles. If Mr. Reid Moir and I are right in regarding the human remains lately found at Ipswich as resting under a bed of undisturbed chalky Boulder Clay—it is right to say that our inferences are contested—then we have carried the history of modern man a step still further back in the Pleistocene period, for the chalky Boulder Clay is the product of the great cold cycle which preceded the Chellean industry. So far as the evidence in England goes it indicates the existence of a modern type of man at least as far back as the middle of the Pleistocene period.

All we know of man in Europe near the beginning of the Pleistocene is the famous lower jaw found near Heidelberg in 1907. A complete lower jaw with its full complement of teeth can tell with certainty a great deal about the individual to which it belonged. There is not a shadow of doubt that the Heidelberg man belonged to the Neanderthal type; perhaps he may best be described as pre-Neandertheloid, for in strength and massiveness of jaw he foreshadows the Neanderthal men whose remains are found in Europe towards the end of the Pleistocene. Of the Neanderthal race in the middle phases of the Pleistocene we have, so far, discovered no trace. Although in many features Neanderthal man shows resemblances to the anthropoids, in others he is highly specialised. The teeth of an Australian native make a nearer approach to the anthropoid condition than those of Neanderthal man.

We have knowledge of another fossil man belonging to the beginning of the Pleistocene. In 1891 Dr. Eugene Dubois discovered in Java the fossil remains of a man who, in stature, posture, and gait, must have been very similar to us, but so unlike us in head form that his discoverer named this new form of man Pithecanthropus. The size of his brain (855 cubic centimetres) was little more than half the size of the brain of a well-developed modern man. The Neanderthal man described by Prof. Boule had a cranial capacity of 1600 or 1625 cubic centimetres. It is usual to accept the fossil man of Java as representative of his time and race, but if we do we have to suppose that, in the early part of the Pleistocene, within a comparatively short space of time, the human brain developed at an astounding and almost incredible rate. I leave the matter there, simply asking my audience to keep in mind that there did exist in the Far East at the beginning of the Pleistocene, or perhaps close of the Pliocene, a very low form of primitive man.

Thus we have a knowledge—a very imperfect knowledge—of only two human individuals near the beginning of the Pleistocene period. The one was brutal in aspect, the other certainly low in intellect. It is hard, then, to believe that in strata belonging to the period preceding the Pleistocene there could be found fossil remains of a man of quite a high and modern type. Yet the details relating to the discovery of human remains by Prof. Ragazzoni in early Pliocene strata of North Italy are so circumstantial and supported that one cannot place them lightly aside. In 1860 Prof. Ragazzoni was searching in undisturbed Pliocene strata for fossil shells; he discovered remains of a human skull. His discovery was received with derision. Between 1860 and 1880 he found in the same strata remains of three further individuals. The only living anthropologist authority, so far as I can learn, who accepts Ragazzoni's discovery as authentic is the celebrated Italian anthropologist—Prof. Sergi, of Rome. If the remains found in these strata had been of a primitive type their authenticity would never have been called in question, but as they represented individuals as highly evolved as we are the easiest solution of the problem was to suppose that by some means these remains had been interpolated in ancient strata at a later date.

Is it, then, possible that a human being, shaped and endowed as we are, may have existed so early as the Pliocene period? If we accept as authentic all the evidence brought forward by those who have traced man backwards by means of flints which have the appearance of man's work on them, then we must admit that Pliocene man is possible, for stones apparently artificially fashioned have been found in strata as old as the Eocene. If, on the other hand, we examine the evidence relating to that group of animals to which man belongs—the higher primates—the facts, so far as we know them, render the existence of man in the Eocene and Oligocene periods impossible, improbable in the Miocene period, but quite possible in the Pliocene. If, finally, we take into consideration all the evidence relating to fossil forms of man we must confess that the antiquity of the modern form of man is still an open problem. I, for one, am convinced that we have followed him almost unchanged to at least the middle of the Pleistocene, when we find him accompanied by another form of man almost as distinct from him as the gorilla is from the chimpanzee. Still further back, at the beginning of the Pleistocene, we find at least two forms of men—the pre-Neanderthal of Heidelberg and the small-brained man of Java—but the representatives of modern man at this early period we do not know. It does seem to me, taking all the scraps of evidence at our disposal, the slow rate of human evolution and the great blanks in the geological record into account, that a man as high as the Australoid of to-day was then in existence, but I cannot bring myself to believe that human individuals so highly evolved as those discovered by Prof. Ragazzoni were in existence at an early part of the Pliocene period.

The problem of man's antiquity is not yet solved. The picture I wish to leave in your minds is that in the distant past there was not one kind, but a number of very different kinds, of men in existence, all of which have become extinct except that branch which has given origin to modern man. On the imperfect knowledge at present at our disposal it seems highly probable that man as we know him now took on his human characters near the beginning of the Pliocene period. How long ago that is must be measured, as Prof. Boyd Dawkins insists, by the changes which the earth and living things have undergone, and yet it is only human to try to find a means of measuring that period in a term of years, and the estimates at hand give an antiquity of at least a million and a half of years.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—A university lectureship in physiology is now vacant by the resignation of Dr. Anderson. The General Board of Studies will shortly proceed to appoint a lecturer to hold office from January 1, 1913, until September 30, 1917. The annual stipend is 50*l.* Candidates are requested to send their applications, with such testimonials as they may think fit, to the vice-chancellor on or before November 12.

London.—The Senate, at its meeting on October 23, made four appointments to University professorships. In one case, the appointment of Mr. Harold Hilton to the professorship of mathematics at Bedford College for Women, the new professor will continue his present work. Dr. J. W. Nicholson has been appointed professor of mathematics at King's College, and Mr. A. H. Jameson professor of civil engineering at the same college. Dr. Nicholson is at present mathematical lecturer at Girton College, and Mr. Jameson is a well-known civil engineer, trained at Manchester University. Dr. F. J. C. Hearnshaw, formerly of Hartley University College, Southampton, and at present professor at Armstrong College, Newcastle-on-Tyne, has been appointed to the professorship of history, tenable at King's College. These new appointments have been made with funds provided by the new grants from the London County Council.

The D.Sc. degree has been granted to the following students:—H. E. Watson, University College, in chemistry; C. H. O'Donoghue, King's and University Colleges, in zoology; Miss E. R. Spratt, King's College, in botany; and Miss E. M. Delf, University College, in botany.

It is announced in *Science* that 20,000*l*., to endow scholarships for young men, has come to the University of California from the estate of Mrs. Carrie M. Jones, of Los Angeles. From the same source we learn that Mount Holyoke's alumnæ committee reports that its efforts to raise 100,000*l*. for the college have met with success. The committee has transferred to President Woolley vouchers for 110,400*l*.

Owing to the appointment of Dr. W. H. Mills to the Jacksonian demonstratorship at Cambridge, in succession to Dr. H. O. Jones, who was killed recently on the Alps, the governors of the Northern Polytechnic Institute, Holloway, London, N., have appointed Dr. H. H. Hodgson head of the chemical department at that polytechnic. Mr. Hodgson was previously lecturer and research chemist at the Bradford Technical College. Also, to fill the vacancy of head of the building department caused by the appointment of Mr. Hugh Davies to be an inspector under the Board of Education, the governors have appointed Mr. J. Campbell Reid to take charge of that department. Mr. Reid was lecturer in building subjects at the Paisley Technical School, and an architect in practice in Glasgow.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, October 14.—M. Lippmann in the chair.—B. **Baillaud**: The seventeenth general meeting of the International Geodesic Association. The meeting, held at Hamburg, September 17–27, was attended by sixty-two delegates representing twenty countries. Details of the subjects discussed are given, and of the resolutions passed by the association.—A. **Lacroix**: Preliminary note on some Madagascar minerals, several of which have been utilised as gems. Amongst the minerals described of exceptional transparency are opal, chalcedony, orthose (golden-yellow), diopside, apatite, kornerupine, saphirine, and zircon.—Pierre **Termier**: The scientific results of the Alpine excursion of the *Geologische Vereinigung*. The lepontine strata in the Tauern. The conclusion is drawn that dynamo-metamorphism does not exist, and the name ought to disappear from science. Rocks are deformed but not transformed by dynamical action.—M. **Gouy**: The kinetic theory of ionised gases and Carnot's principle. The study of a gas, maintained adiabatically at a temperature such that a very small fraction of its molecules are decomposed with ions of opposite signs, and placed in a uniform magnetic field, leads to conclusions that are in contradiction with Carnot's principle. If this principle holds, then, alternatively, it is necessary to reject the possibility of the ionisation of a gas by a rise of temperature alone. The author regards the latter view as opposed to experiment, and points out that the magnetic field may be regarded as acting like Clerk Maxwell's demon, which, without supplying energy, exercises a directive and selective action on the particles.—Édouard **Heckel**: The influence of removal of the sex organs, male, female, and total, on the formation of sugar in the stems of maize and sorghum. The removal of both the sex organs in these plants leads to a marked increase in the proportion of sugar present.—J. **Guillaume**: Observations of the Gale comet (1912*a*) made with the Brunner equatorial at the Observatory of Lyons. Positions are given for October 9, 10, 12, 14, and 15. The comet is circular, with a central condensation round a stellar nucleus; it was about the 8th magnitude on October 9, increasing to 5·5 on October 15.—M. **Borrelly**: Observations of the 1912 Gale comet, made at the Observatory of Marseilles, with the comet-finder. Positions given for October 4 and 5.—P. **Chofardet**: Observations of the Gale comet (1912*a*), made at the Besançon Observatory with the 33 cm. bent equatorial. Positions given cr six days between September 27 and October 12. On October 10 the shape of the tail could be made out.—Ernest **Esclangon**: The orientation of photographic equatorials. It is pointed out that one method current is defective in principle, and a better alternative method is proposed.—A **Petot**: Conjugate systems.—Henri **Lebesgue**: The principle of Dirichlet.—Jules **Andrade**: A point still under discussion in the study of marine chronometers. A discussion of the variation from isochronism due to the inertia of the balance-spring.—J. de **Boissoudy**: Molecular association in gases.—L. G. **Droit**: The opacity to the X-rays of tissues suitably loaded with a dye containing lead salts. Silk is loaded with phosphostannate of lead to the extent of 68 per cent. of mineral matter, half of which is lead. Six thicknesses of this material form an effective screen against the X-rays, and for soft rays even two or three thicknesses are sufficient.—A. **Guillet** and M. **Aubert**: The electrical attraction of two conducting spheres; the properties of the families of polynomials occurring in this problem and their relations with the spherical Heine-functions of higher order.—M. **Besson**: The dissymmetry of the positive and negative ions relating to the condensation of water in an atmosphere of carbonic acid.—M. **Hanriot**: The hardness of metals. It is shown that the hardness of the metal is altered in carrying out Brinnel's test, with the result that the figures for hardness with an annealed metal come out too high.—Félix **Robin**: The production of voluminous grain in metals.—Albert **Colson**: The law of mass action. Its contradictory verifications and its defence, by M. Le Chatelier.—Georges **Denigès**: A new very sensitive reaction characteristic of free bromine. A solution of rosaniline, decolorised with bisulphite and mixed with a little hydrogen peroxide, gives a violet coloration in presence of free bromine. The colouring matter formed is soluble in choloroform and gives a characteristic absorption spectrum.—Maurice **Durandard**: Variations of the most favourable working temperature under the influence of the medium in *Mucor rouxii*.—G. **Arnaud**: The cytology of *Capnodium meridionale* and of its mycelium.—André **Mayer** and Georges **Schaeffer**: The chemical composition of the blood and hæmolysis. The corpuscles from different animals are unequally resistant to serums of different species. It has been found that the order of increasing resistance is the same as the amounts of non-volatile fatty acids present in the corpuscles. The hæmolytic power of the different sera was found to correspond with the amounts of cholesterol present in the sera.—Em. **Bourquelot** and H **Hérissey**: The synthesis of the galactosides of alcohols with the aid of emulsin. β-Ethylgalactoside.—Romuald **Minkiewicz**: A case of extraordinary reproduction in *Polyspira delagei*.—Léon **Bertrand** and Louis **Mengaud**: The existence of several superposed strata in the Cantabrian Cordillera, between Santander and Llanes.—L. **Cayeux**: The structure of the Urville (Calvados) basin and its consequences from the point of view of working for minerals containing iron.

October 21.—M. Lippmann in the chair.—H. **Deslandres**: Additional remarks on the protuberances, *alignements*, and filaments of the upper solar atmosphere. The influence of the solar electric field.—Th. **Schlœsing**, sen.: The measurement of flowing water by chemical analysis. A concentrated solution of ammonium sulphate of known strength was allowed to flow at a measured rate into the watercourse; the latter was then sampled at a point lower down, and from the concentration in ammonia the flow per second was deduced with fair accuracy.—Henry **Le Chatelier**: The law of mass action. Final reply to M. Colson.—L. **Maquenne** and E. **Demoussy**: Respiration in green plants. A critical review of the methods of determining respiration in plants. The rapid decrease in the respiratory coefficient of a freshly-cut organ as a source of error in such measurements is pointed out, and also the effects of darkness in altering the coefficient in old and young leaves.—A. **Schaumasse**: The discovery and observation of the comet 1912*b* (Schaumasse) made at the Nice Observatory. The comet was of the 11·5 magnitude on October 18; on the following day it appeared as a rounded nebulosity about 3′ in diameter, with a badly defined condensation.—M. **Giacobini**: Observations of the new Gale comet (1912*a*). Daily observations are given from October 3 to 13.—P. **Brück**: Observations of the Gale comet (1912*a*) made at the Observatory of Besançon. Positions given for October 13, 14, 16, 18. The tail was clearly visible.—Léon **Autonne**: Cremonian substitutions.—T. H. **Gronwall**: A theorem of M. Picard.—George **Polya**: A theorem of Stieltjes.—P. **Helbronner**: The complementary geodesic triangulations of the higher regions of the French Alps (second series).—E. **Mérigeault**: The influence of the velocity of combustion on the efficiency of a gas motor.—Paul **Jégou**: The use of horizontal wires for receiving Hertzian waves. A single horizontal wire 80 metres long failed to detect the time-signal from the Eiffel Tower, but with two such wires, 40 cm. apart, good signals were obtained. Telephone or telegraph wires can be utilised in this way if a small condenser is placed in the circuit to suppress parasitic currents.—P. Th. **Muller** and Mlle. V. **Guerdjikoff**: The refraction and magnetic rotation of mixtures. Further evidence is given tending to show that the expression of H. Becquerel connecting the refraction and magnetic rotation is not general.—Maurice **Billy**: A simple method for the preparation of mineral oxides. A mixture of a metal with its higher oxide, both in a finely divided condition, heated to a high temperature with precautions to prevent the access of air, gives a lower oxide. Details are given of the application of the method to the preparation of Ti_2O_3 and TiO.—Lucien **Daniel**: Grafts of the carrot on fennel.—P. **Mazé**: Researches on the presence of nitrous acid in the excretions of the higher plants.—Marcel **Mirande**: A new group of plants producing hydrocyanic acid, the Calycanthaceæ. The production of hydrocyanic acid from the leaves of three species of Calycanthus has been proved.—H. **Vincent**: The action of polyvalent antityphoid vaccine in persons in a state of latent infection by the Eberth bacillus. The injection of the polyvalent typho-vaccine never produces a negative phase. Not only do these injections never aggravate the disease, but they exercise a favourable action on the course of the disease. Taken before the infection is incurred, the immunity produced appears to be absolute.—Paul **Paris**: The presence of Herbst corpuscles in the uropygian gland of birds.—C. **Delezenne** and M. **Lisbonné**: The action of the ultra-violet rays on the pancreatic juice. Their influence on the stimulation of the juice by kinase and by calcium salts. The enzymes in the pancreatic juice present different resisting powers to the action of the ultra-violet rays. After a certain time, two to three hours, the liquid loses its property of being rendered active by the addition of calcium salts, although still reactive with kinase. At the same moment that the juice loses its power of reacting with calcium salts, it is also deprived of its lipasic properties.—L. **Lindet**: The antiseptic action of salt and sugar. A study of the amounts of nitrogen, phosphoric acid, and potash extracted from yeast cells by solutions of common salt and of sugar of varying concentrations.—M. **Lemoigne**: The fermentation of sugar by *Bacillus subtilis*. The production of 2 : 3-butylene glycol. The action of *B. subtilis* upon sugar under ærobic conditions takes place in two phases, the first a fermentation leading to the production of 2 : 3-butylene glycol, $CH_3.CH(OH).CH(OH).CH_3$, and this is then oxidised to acetylmethyl-carbinol, $CH_3.CH(OH).CO.CH_3$. By the further action of the organism the latter substance is destroyed.—MM. **Couyat** and **Fritel**: The imprints (Medusæ, Algæ) collected in the carboniferous deposits in the neighbourhood of Suez.—F. **Dienert**: The solution of silica in underground waters.

BOOKS RECEIVED.

Grundzüge der tektonischen Geologie. By Dr. O. Wilckens. Pp. viii+113. (Jena: G. Fischer.) 3.50 marks.

Alcune Misure Magnetiche Eseguite nell' Est-Africa Inglese e nella Somalia Italiana. By L. Palazzo. Pp. 37+map. (Roma: Tipografia Nazionale di G. Bertero e C.)

Visual Geography. By A. Nightingale. Pp. 48. (London: A. and C. Black.) 6*d*.

The Keuper Marls around Charnwood. By T. O. Bosworth. Pp. 129. (Leicester: Literary and Philosophical Society.)

Theoretical and Practical Mechanics and Physics. By A. H. Mackenzie and A. Forster. Second edition. Pp. xvi+214. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Principles of Economics. By Dr. N. G. Pierson. Vol. ii., translated by A. A. Wotzel. Pp. xxiii+645. (London: Macmillan and Co., Ltd.) 10*s*. net.

The Adventures of an Elephant Hunter. By J. Sutherland. Pp. xviii+324. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

The Rock Garden. By R. Farrer. Pp. xi+118. (Edinburgh and London: T. C. and E. C. Jack.) 1*s*. 6*d*. net.

Tulips. By Rev. J. Jacob. Pp. xi+116. (Edinburgh and London: T. C. and E. C. Jack.) 1*s*. 6*d*. net.

The Significance of Ancient Religions in Relation to Human Evolution and Brain Development. By Dr. E. N. Reichardt. Pp. xiv+456. (London: G. Allen and Co., Ltd.) 12*s*. 6*d*. net.

Lessons from Nature's Workshop. By W. J. Claxton. Pp. 192. (London: G. G. Harrap and Co.) 1*s*. 6*d*. net.

Cave, Mound and Lake Dwellers and other Primitive People. By F. Holbrook. Pp. 130. (London: D. C. Heath and Co.) 1s. 6d. net.

Vapours for Heat Engines. By Prof. W. D. Ennis. Pp. iv+77. (London: Constable and Co., Ltd.) 6s. net.

La Théorie des Ions et l'Électrolyse. By A. Hollard. Deuxième Édition. Pp. vii+220. (Paris: Gauthier-Villars.) 5 francs.

Die Einteilung der Pflanzengesellschaften. By H. Brockmann-Jerosch and E. Rübel. Pp. vi+72. (Leipzig: W. Engelmann.)

Aus Natur und Geisteswelt. Astronomie. By A. Marcuse. Pp. 99. Die Chirurgie unserer Zeit. By Prof. J. Fessler. Pp. 138. Der Mond. By Prof. J. Franz. Zweite Auflage. Pp. 120. Die Befruchtung und ihre Beziehung zur Vererbung. By Dr. E. Teichmann. Zweite Auflage. Pp. iv+96. (Leipzig: B. G. Teubner.) Each 1.25 marks.

Ceramic Chemistry. By H. H. Stephenson. Pp. vii+91. (London: Davis Bros.) 6s.

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. 25 Lief. Band i. Zweite Hälfte. Pp. 161–320. 26 Lief. Band iii. Erste Hälfte. Pp. 161–320. 27 Lief. Band iii. Erste Hälfte. Pp. 321–484. 28 Lief. Band iv. Pp. 841–976. (Jena: G. Fischer.) Each 5 marks.

British Violets. By Mrs. E. S. Gregory. With an introduction by G. C. Druce. Pp. xxiii+108. (Cambridge: W. Heffer and Sons, Ltd.) 6s. net.

Second Stage Inorganic Chemistry (Theoretical). By Dr. G. H. Bailey. Sixth Impression. Revised by H. W. Bausor. Pp. viii+544. (London: W. B. Clive.) 4s. 6d.

Baby Birds at Home. By R. Kearton. Pp. xv+128. (London: Cassell and Co., Ltd.) 6s.

Memoranda Mathematica. By W. P. Workman. With Five-figure Logarithmic and Trigonometrical Tables, arranged by W. E. Paterson. Pp. v+272+28. (Oxford: Clarendon Press.) 5s. net.

The Story of the Heavens. By Sir R. S. Ball. Part i. Pp. 48. (London: Cassell and Co., Ltd.) 6d. net.

Nervation of Plants. By F. G. Heath. Pp. vi+187. (London: Williams and Norgate.) 3s. 6d. net.

Experimental Physiology. By Prof. E. A. Schäfer. Pp. viii+111. (London: Longmans and Co.) 4s. 6d. net.

Elementary Algebra. By W. M. Baker and A. A. Bourne. Ninth edition. Pp. xi+lxxvii. (London: G. Bell and Sons, Ltd.) 4s. 6d.

Bacon's Excelsior Map of the Mediterranean Lands. Cloth, rollers, and varnished; on cloth cut to fold. (London: Bacon and Co., Ltd.) Each 16s.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. ii., part 6. (Sydney: W. A. Gullick.)

DIARY OF SOCIETIES.

MONDAY, NOVEMBER 4.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Nitrogenous Constituent of Para Rubber and its bearing on the nature of Synthetic Rubber: Clayton Beadle and H. P. Stevens.—The Corrosion of Metals and Alloys in various Solvents: A. J. Hale.—The Viscosity of Lubricating Oils: A. E. Dunstan and J. F. Strevens.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geography of Japan and its Economic Development: Miss E. C. Semple.

ARISTOTELIAN SOCIETY, at 8.—The Notion of Cause: Hon. Bertrand Russell.

SOCIETY OF ENGINEERS, at 7.30.—The Generation and Electrical Transmission of Power for Marine Transportation: W. P. Durtnall.

TUESDAY, NOVEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Inaugural Address by the President (Mr. R. Elliott Cooper) and Presentation of Medals awarded by the Council.

WEDNESDAY, NOVEMBER 6.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Detection and Estimation of Arachis Oil: N. Evers.—The Examination of Chinese and Japanese Wood Oil: A. Chaston Chapman.—The Estimation of Manganese by the Bismuthate Method: H. F. V. Little.

GEOLOGICAL SOCIETY, at 8.—A Contribution to our Knowledge of Wealden Floras, with special reference to a Collection of Plants from Sussex: Prof. A. C. Seward.—Notes on the Discovery of Fossiliferous Old Red Sandstone Rocks in a Boring at Southall, near Ealing: E. Proctor. With an Appendix on the Upper Devonian Fish-Remains: Dr. A. Smith Woodward.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 7.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Radiation and Absorption of Light in Gaseous Media, with Applications to the Intensity of Sky Radiation: L. V. King.—A Standard Measuring Machine: Dr. P. E. Shaw.—A Spectro-photometric Comparison of the Emissivity of Solid and Liquid Gold at High Temperatures with that of a Full Radiator: E. M. Stubbs and Dr. E. B. R. Prideaux.—Optical Properties of Substances at the Critical Point: C. Smith.—Absorption of Helium and other Gases under the Electric Discharge: Hon. R. J. Strutt.—(1) The Discharge between Concentric Cylinders in Gases at Low Pressures; (2) The Influence of the Nature of the Kathode on the Length of the Crookes Dark Space. F. W. Aston.—The Determination of the Absolute Unit of Resistance by Alternating Current Methods: A. Campbell.—Some Unclassified Mechanical Properties of Solids and Liquids: A. Mallock.—Tricbromatic Theory of Colour Vision. The Measurement of Fatigue of the Retina: Sir W. de W. Abney, K.C.B.

FRIDAY, NOVEMBER 8.

PHYSICAL SOCIETY, at 8.—On a Method of Measuring the Thomson Effect: H. R. Nettleton.—An Improved Joule Radiometer and its Applications: F. W. Jordan.—Note on the Attainment of a Steady State when Heat Diffuses along a Moving Cylinder: Miss A. Somers.—The Thermomagnetic Study of Steel: S. W. J. Smith.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—Tivella and Grateloupia: A. J. Jukes-Browne.—Some Remarkable Shell Monstrosities: G. C. Robson.—New Mollusca from the Marine Tertiary Deposits of the North Pacific Coast of America: Ralph Arnold and Harold Hannibal.—Descriptions of new species of Limicolaria and Krapfiella from East Central Africa: H. B. Preston.

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THURSDAY, NOVEMBER 7, 1912.

MATHEMATICAL TEXT-BOOKS.

(1) *A Treatise on Plane Trigonometry.* By Prof. E. W. Hobson, F.R.S. Third edition. Pp. xv+383. (Cambridge University Press, 1911.) Price 12*s*. net.

(2) *A Shorter Geometry.* By C. Godfrey, M.V.O., and A. W. Siddons. Pp. xxii+301. (Cambridge University Press, 1912.) Price 2*s*. 6*d*.

(3) *A New Geometry.* Books i–iii. By W. M. Baker and A. A. Bourne. Pp. xxii+122+iii. (London: G. Bell and Sons, Ltd., 1912.) Price 1*s*. 6*d*.

(4) *Lessons in Geometry.* Part i. By Dr. Charles McLeod. Pp. xii+212. (Aberdeen University Press, 1912.) Price 2*s*. 6*d*. net.

(5) *Examples in Arithmetic.* Part i., with answers. Taken from "A School Arithmetic." By H. S. Hall and F. H. Stevens. Pp. ix+115+xxii. (London: Macmillan and Co., Ltd., 1911.) Price 1*s*. 6*d*.

(6) *Solutions of the Examples in Godfrey and Siddons's "Solid Geometry."* By C. L. Beaven. Pp. 164. (Cambridge University Press, 1912.) Price 5*s*. net.

(7) *A B C of Hydrodynamics.* By Lieut.-Col. R. de Villamil. Pp. xi+135. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1912.) Price 6*s*. net.

(8) *A New Algebra.* By S. Barnard and J. M. Child. Volume ii. Containing Parts iv.–vi. Pp. x+301–731. (London: Macmillan and Co., Ltd., 1912.) Price 4*s*.

(9) *A Treatise on the Analytical Geometry of Three Dimensions.* By Dr. George Salmon, F.R.S. Revised by Reginald A. P. Rogers. Fifth edition. In two volumes. Vol. i. Pp. xxii+470. (London: Longmans, Green and Co.; Dublin: Hodges, Figgis and Co., 1912.) Price 9*s*.

(10) *Fergusson's Percentage Unit of Angular Measurement, with Logarithms; also a Description of his Percentage Theodolite and Percentage Compass.* For the use of Surveyors, Navigating Officers, Civil and Military Engineers, Universities and Colleges. By John Coleman Fergusson. Pp. lxvii+467. (London: Longmans, Green and Co., 1912.) Price 3*l*. 3*s*. net.

(11) *An Elementary Treatise on Statics.* By Prof. S. L. Loney. Pp. viii+393. (Cambridge University Press, 1912.) Price 12*s*.

(1) PROF. HOBSON'S treatise on plane trigonometry has for many years been regarded as the best work on the subject available for English students. There is probably no lecturer at Oxford or Cambridge who does not recommend his pupils to read it. In fact, before its publication it was necessary for those who wished for a rigorous treatment of those infinite series and products which occur in higher trigonometry to have recourse to French or German text-books. But recently much has been done in England to remedy this deficiency. Mr. Hardy's volume on "Pure Mathematics," Prof. Bromwich's work on "Infinite Series," and Prof. Hobson's "Theory of Functions of a Real Variable" are noteworthy examples. These, however, deal with a wider field, and students will still continue to gain their first insight into the problems of higher analysis from this volume.

The need of a third edition has given the author an opportunity for a complete revision; new matter has also been inserted. The theory of the measurement of circular arcs is discussed at some length in the opening chapter. Those who are interested in mathematical history will appreciate the section on the quadrature of the circle, in which is given a modified form of Gordon's proof that π is a transcendental number, thus establishing the impossibility of constructing by Euclidean methods a straight line bearing to a given straight line the ratio π. But the most important changes in the work are those which relate to the theory of series and products. Many additions have been made, further examples are given to illustrate the different cases that arise, and a number of references are supplied for those who wish to make a more thorough study of the subject. We have no doubt that this volume will retain its place as the standard text-book for many years to come.

(2) This volume is a carefully reasoned interpretation of the Board of Education circular on the teaching of geometry. The first stage aims at illustrating the fundamental concepts, the second leads to the discovery of the principal theorems, and the third builds up on this basis a deductive development of the subsequent propositions. The authors feel that too much time has in the past been devoted to purposeless drawing, and have therefore omitted much of the experimental work contained in their previous treatise; the number of theoretical exercises, on the other hand, has been increased. We shall be much surprised if this text-book is not widely used.

(3) This is an abbreviated form of the textbook on elementary geometry by the same authors published nine years ago. The only important change is the redistribution of the propositions in Book i., those on congruent triangles being now

grouped together. The supply of riders, particularly in connection with angle properties of the circle, seems rather inadequate. We are glad to see that limit methods of proof are employed for the fundamental tangent properties.

(4) There are several novel features in this text-book. It is divided into thirty-five sections, each of which professes to contain the material for one lesson; but we are inclined to think some of these sections will occupy four or five hours if an adequate amount of time is assigned to rider work. The theorems are not numbered, and no references to previous propositions are given in the proofs; a conversational method is employed which for beginners possesses obvious advantages, and the order of the theorems differs from that usually followed. The scope of the work includes the first three books of Euclid, the properties of similar figures, and the fundamental propositions of solid geometry. We are of opinion that the character of the book will render it more useful to the teacher than to the student.

(5) In order to meet the wishes of those teachers who prefer to take all book-work orally, the authors have now issued in a separate form the exercises contained in their "School Arithmetic." The work is published in two parts, the first of which deals with fractions, decimals, factors, compound quantities, and unitary method. Both in quality and variety the collection of examples is admirable.

(6) Many teachers will be glad to hear that the solutions of the exercises in Godfrey and Siddons's "Solid Geometry" have now been published. Where we have tested them we have found that they are set out very clearly. Mr. Beaven has avoided the temptation to which in such cases writers often succumb of allowing a desire for brevity to obscure lucidity of expression. The figures which illustrate the solutions of the problems on plan and elevation are drawn with great care, and the methods employed are fully explained.

(7) This is in no sense a text-book on hydrodynamics. A few formulæ are quoted from various mathematical treatises, but no proofs are given. The purpose of the author is to introduce the student to the ideas of the subject, and to point out the rather arbitrary conditions under which, in the present state of knowledge, the mathematician is compelled to work. We do not think that the novice will find the contents of this volume at all easy to understand and coordinate with his other scientific reading. The number of quotations from many different authorities and the variety of topics alluded to may well tend to confuse those who have little previous knowledge of the subject. In the hands of a skilled lecturer we think the material of this book and the lines of thought indicated would interest and stimulate a class of students of ordinary ability. The character of the work leads us to believe that the author's purpose would be achieved with a real measure of success by oral methods.

(8) The authors of this treatise have succeeded in producing a work wholly unlike any other text-book on the subject with which we are acquainted. They take as their motto a pregnant sentence from Tannery's "Leçons d'algèbre et d'analyse":—"J'ai horreur d'un enseignement qui n'est pas toujours sincère; le respect de la vérité est la première leçon morale, sinon la seule, qu'on puisse tirer de l'étude des sciences." Their contention is that the average schoolboy is fully capable of realising the fundamental ideas upon which the science of algebra and, in fact, all analysis is based, and that a powerful educative instrument is discarded if no attempt is made to discuss the base-principles of the subject. They regard rigour in fundamentals as important as variety in application, and the power to understand the meaning of a process as more valuable than the ability to apply it.

With these ideas in the abstract few people will disagree, but the majority of teachers hold that work of this character must be reserved for specialists. They consider that the mental calibre of the ordinary schoolboy, and the limited time at his disposal, are scarcely adequate to permit of the high standard required by the authors of this work. Great things can, of course, be done by an enthusiastic and able teacher; and we have no doubt at all that Mr. Barnard obtains excellent results at Rugby by following the lines here indicated. But we question whether the ordinary teacher could be expected to meet with success. We have not the space to comment in any detail on the contents of this volume, but we would urge teachers to procure a copy and study it for themselves. They will find in it much that is highly suggestive, and will gather from it a number of new ideas. It is in every respect a remarkable work.

(9) By the direction of the Board of Trinity College, Dublin, a new edition of Dr. Salmon's treatise on analytic geometry of three dimensions has been prepared. The editor has retained the substance of what appeared in the fourth edition, but has brought it into line with more recent work by inserting a number of new sections; the list of references has also been supplemented. Among the additions that have been made we note some excellent plates showing models of the various species of quadrics, a paragraph on Fiedler's pro-

jective coordinates, an account of the parametric representation of twisted cubics and quartics, Staude's elegant thread construction for confocal ellipsoids, and considerable reference to the later results obtained in differential geometry. There are a large number of minor changes, but the numbering of articles and chapters remains unaltered. Mr. Rogers is to be congratulated on the way in which he has executed a far from easy task.

(10) The author claims that the method explained in this volume abbreviates and simplifies very materially the work of surveyors and navigators. It is, of course, impossible for us to judge from a perusal of the book how far the theodolite which Mr. Fergusson has invented is successful in practical work. But Prof. Heath states that it has been tested in the engineering department of Birmingham University, and has proved extremely convenient. He also remarks that

"the reduction of the results of observations can be carried on simultaneously with the field work without reference to books of tables, thus giving the surveyor full information about any part of the field observed, while he is on the spot. For all traverse surveying, especially for rapid preliminary traverse, subject to modification, the instrument possesses distinct advantages over the ordinary theodolite."

The fundamental idea in the construction of the instrument lies in the method of graduation. To explain the system adopted, we will suppose that OA_0, OA_{100} are two radii of the circle, containing an angle of 45°. Then points A_1, A_2, . . . A_r . . . are marked on the rim such that the tangent of the angle A_rOA_0 is equal to $r/100$, where r takes all values from 1 to 100. By this means it is clear that the observer, instead of reading off the angle, obtains its tangent, which is more useful for his purpose. As a matter of fact, the new form of theodolite is also graduated in degrees so that the angle can also be obtained, if desired. The angle A_1OA_0 is taken as unit, and is called the one per cent. angle.

The first fifty pages explain very fully the theory, and numerous examples are given to show its application. The remaining 450 pages are occupied with tables, to the compilation of which the author has given nineteen years. The leading column gives the angle in the percentage form at intervals of 0·001 per cent. below 1 per cent., and of 0·01 per cent. above it. The other columns give logarithmic sines, cosines, tangents, secants with difference tables to seven places of decimals, and the angle in degrees to 0·001 of a second. A shorter table at the end contains tangents of half angles and versines. It seems almost incredible that any one man should have been able to carry through, almost single-handed, such a laborious work as Mr. Fergusson has accomplished. It undoubtedly merits the serious consideration of those engaged in survey work. The bulky size of the volume gives it rather an alarming appearance, but the processes are in reality very simple, and a single hour's work with the instrument would probably be enough to enable any practical man to gauge its utility.

(11) There is a distinct need for a treatise on statics suitable for candidates for entrance scholarships at the universities. A number of excellent introductory text-books exist, but with two possible exceptions we do not know of any work which exactly meets this demand. Many teachers will therefore welcome the publication of Prof. Loney's book, which may be regarded as a companion volume to his "Dynamics of a Particle and of Rigid Bodies," recently issued. It is assumed that the student possesses some knowledge of the methods of the calculus and the elements of analytical solid geometry. In addition to the ordinary elementary course, it contains chapters on shearing stresses, three-dimensional forces, wrenches, chains, attractions and potential, and slightly elastic beams. There is an excellent collection of examples, including some of very considerable difficulty. The author has the rare gift of writing simply, and he has chosen his material with the same skill that characterises his previous work.

PHILOSOPHY AND PSYCHOLOGY.

(1) *Scientific Method: its Philosophy and its Practice.* By F. W. Westaway. Pp. xxi+439. (London: Blackie and Son, Ltd., 1912.) Price 6*s*.

(2) *Proceedings of the Aristotelian Society.* New Series. Vol. xii. Containing the Papers read before the Society during the Thirty-third Session, 1911–1912. Pp. ii+345. (London: Williams and Norgate, 1912.) Price 10*s*. 6*d*. net.

(3) *Anales de Psicologia.* Trabajos del año 1910. Volumen ii. Pp. 360. (Buenos Aires: *La Semana Médica.* Imp. de Obras de E. Spinelli, 1911.)

(1) AN excellent book for science teachers and for the general reader who wishes to acquaint himself with scientific method. Beginning with the consideration of words and the importance of exactness in their use, Mr. Westaway enters on a sketchy history of philosophy, dealing with Plato, Aristotle, Bacon, Descartes, Locke, and Hume. Thence he proceeds to logic,

explaining its function in scientific method, and naturally giving prominence to J. S. Mill, though also quoting Whewell, Bain, Jevons, Alfred Sidgwick, and Welton. Book iii. consists of useful examples of scientific procedure, drawn from the investigations of White of Selborne, A. R. Wallace, Darwin, Harvey, Lord Avebury, and others; while book iv. deals with some elementary principles of science-teaching, and has some very sensible remarks on heuristic methods. The section on Bacon is particularly good, and the famous idols are lucidly explained. Indeed, the whole book is a model of clearness. If it has a fault, it is in the direction of excessive quotation; but this is difficult to avoid when an author is exceptionally well read, and it has the compensating advantage of giving the young student a wide range of actual "samples," some of which may lure him to the study of the authors themselves.

(2) This volume contains papers by Bertrand Russell, Percy Nunn, Boyce Gibson, Dawes Hicks, W. R. Sorley, James Ward, Bernard Bosanquet, and others, on the relations of universals and particulars, animism and the doctrine of energy, the experience of power, the time difficulty in realist theories of perception, and purpose and mechanism. Perhaps the most interesting to the man of science—particularly in view of Prof. Schäfer's British Association address and the various comments thereon—is the symposium on purpose and mechanism. Prof. Sorley, instancing a workman laying the bricks in house-building, points out that the purposive process involves (1) no creation or annihilation of matter, but only rearrangement of masses; (2) no creation or annihilation of energy; (3) no violation of the law of causation; but that it is by no means established that the laws of mechanics are valid also for purposive action; *e.g.*, the laws of motion do not explain the bricklayer. It is "ideal guidance"—guidance by the idea of the house or its parts, existing in the bricklayer's mind—that determines the place of each brick. Purposive action implies certain things which are inconsistent with fundamental principles of mechanics. "Energy is liberated, that is, passes from the potential to the kinetic form, as the result of a purpose, or mental idea, and the same purpose may control the direction of the movement. . . . If purposive action is a reality, then mechanism is an abstract or limited system, and cannot give an adequate account of the real process of things."

Mr. A. D. Lindsay, criticising, remarks that we cannot introduce a non-mechanical into a mechanical system, however much we may insist that it is only a little one; but, at the same time, we can maintain that the mechanical explanation will apply to every part of the human organism, while still holding that this is not a full account of the matter. The discussion was continued by Dr. Bosanquet and Prof. James Ward.

(3) A paper by the late Dr. Ameghino describes fossil remains of two human beings found on the Atlantic coast, 60 kilometres north of Necochea. The skeletons were small, almost pigmy, say about 1·40 metres, and of small build as to strength; skulls small, and decidedly dolichocephalic: frontal part small, face prognathous. Other articles discuss intellectualism and pragmatism, the psychology of criminals, and multiple personality.

J. A. H.

GENERAL AND ECONOMIC GEOLOGY.

(1) *Earth Features and their Meaning.* An Introduction to Geology for the Student and the General Reader. By Prof. W. H. Hobbs. Pp. xxxix + 506. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1912.) Price 12*s.* 6*d.* net.

(2) *A Geological Excursion Handbook for the Bristol District.* By Prof. S. H. Reynolds. With an Introduction by Prof. C. Lloyd Morgan, F.R.S. Pp. 224. (Bristol: J. W. Arrowsmith, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1912.) Price 3*s.* 6*d.* net.

(3) *An Introduction to British Clays, Shales, and Sands.* By A. B. Searle. Pp. xi + 451. (London: C. Griffin and Co., Ltd., 1912.) Price 7*s.* 6*d.* net.

(4) *Graphical Solution of Fault Problems.* By C. F. Tolman, jun. Pp. 43. (San Francisco: Mining and Scientific Press; London: Mining Magazine, 1911.) Price 4*s.* 6*d.* net.

(5) *Observations on the West of England Mining Region.* Being an Account of the Mineral Deposits and Economic Geology of the Region, and forming Vol. xiv. of the Transactions of the Royal Geological Society of Cornwall. By J. H. Collins. Pp. xxiv + 683 + 18 plates. (Plymouth: Wm. Brendon and Son, Ltd., 1912.)

(6) *Types of Ore Deposits.* Edited by H. Foster Bain. Pp. 378. (San Francisco: Mining and Scientific Press; London: Mining Magazine, 1911.) Price 8*s.* 6*d.* net.

(1) PROF. HOBBS describes his new volume as "a series of readings," the substance of a course of lectures in expanded form. The title concisely expresses the character and scope of the work. The author discusses the figure of the earth, and lays stress upon the tetrahedral hypothesis. He touches lightly on rocks and their mode of formation; deals with earth movements, volcanic action, weathering, and the activities of

water and ice, desert conditions, and the characteristics of lakes and mountains. A separate chapter is devoted to the Niagara Falls as a clock of geological time. He hints that a large amount of original and unpublished material is interwoven in the older web. This may be, but much of it has either been skilfully concealed, or it has a familiar look. The book is quite pleasant reading, and the pleasure is enhanced by the abundant and excellent illustrations. There are five appendices; two on the determination of common minerals and rocks are unsatisfactory and not necessary in a book of this kind. The third describes the author's method of explaining the meaning of contoured maps by means of apparatus; it seems an elaborate way of passing the student's time. The fourth is a short explanation of apparatus for teaching the interpretation of geological maps; it consists of different shaped blocks, representing outcrops of various kinds, to be disposed on a table ruled into squares. This might be useful in setting examination exercises. The fifth outlines several fairly lengthy geological trips in the United States, and concludes with a sketch of a geological rush across Europe.

(2) A different series of geological excursions is provided for by Prof. Reynolds in his admirable little guide book. Forty excursions, all within easy distance of Bristol, are described on a uniform plan under the headings "special features," "access," "general structure," followed by, in each case, an itinerary with geological notes and a short list of references. There are numerous sketch maps and sections and an introduction to the geology of the district is written by Prof. Lloyd Morgan.

(3) The literature on British clays and sands is so meagre that any serious attempt to deal with the subject is welcome. The frontispiece to Mr. Searle's book, a "map of the chief clay works in Great Britain," is fairly characteristic of much that is to follow; it presents a medley of dots conveying no information of any value whatever, but representing, no doubt, a great deal of labour. It would be incorrect to suggest that no information can be gained from the text; Mr. Searle has produced a book containing much useful and interesting matter; one who can stand the fatigue and irritation caused by the lack of arrangement and the interminable repetitions will be able to extract a great deal. Only about half the volume is devoted to the geological position, the qualities and uses of British clays, and the small amount of space allotted to sands is not sufficient to warrant any mention in the title. The remainder of the book is concerned with ordinary geology and with the properties of clays in general. Much of the geology might have been condensed or omitted; it is very bookish, and it would be easy to point out many statements that are misleading or only half true. There are chapters on the mineral and other constituents of clays; the physical and chemical properties of clays (the table of analyses is quite inadequate); materials similar to clay (including halloysite, sillimanite, kyanite, zeolites, &c.); prospecting, mining, and quarrying; the purification and preparation of clays and the legal position of clays. There is a large but not quite trustworthy index. Throughout the work there are scarcely any references to original authorities, though many are mentioned.

(4) Prof. Tolman's small book of less than fifty pages deals with a subject of the greatest importance to all practical geologists and mining engineers. In most English text-books the movement on fault planes is usually treated as if it were quite simple, though everyone is aware that it has often been very complicated. The author explains very briefly, and on the whole clearly, how to represent the effects of faulting. He uses for this purpose two methods: the isometric projection, and the application of contouring. He introduces several terms in the nomenclature of fault movements which will be familiar to readers of American geological literature; his use, however, of the expression "pole" for axis is not fortunate. The book would have been more satisfactory in some respects if the author had permitted himself a little more elaboration in the treatment of the subject; it is none the less a useful pamphlet.

(5) On the mining region of Cornwall and Devon Mr. Collins has produced a valuable work of reference. Perhaps the most acceptable portion will be that giving short histories of individual mines. There is also a separate list of mines arranged alphabetically. A large part of the volume is occupied with theoretical matters of the usual kind, mingled with which is more interesting local information as to the character of the ore bodies. Occasionally the author launches out into elaborate estimates of the amount of certain minerals and ores contained in the rocks; they are neither of much use nor very accurate.

(6) It was an excellent idea to gather into a single volume the opinions of different mining engineers upon the type of ore formation with which each was most familiar. Separate chapters of this book are given to the Clinton iron ores, Lake Superior iron ores, the flats and pitches of the Wisconsin lead and zinc district, lead and zinc deposits of the Ozark region, native copper deposits, the Cobalt district of Ontario, the Treadwell mines, Alaska, saddle reefs, contact deposits,

the Witwatersrand conglomerates, replacement ore bodies, outcrops of ores, causes of ore shoots. A great deal of the information has appeared before, and there is naturally a certain amount of divergence of opinion among the writers.

OUR BOOKSHELF.

Leitfaden zum Bestimmen der Vögel Mittel-Europas, ihrer Jugendkleider und ihrer Nester nach leicht und sicher erkennbaren Merkmalen. By Prof. F. Dahl. Pp. viii + 162. (Berlin: Gebrüder Borntraeger, 1912.) Price 5.20 marks.

THE existing handbooks of bird-classification and description are deficient in three important particulars. They are inexact and incomplete on the distinction between immature, mating and ordinary adult plumages. Descriptive adjectives, such as "short" and "long," which have none but a relative application, are used instead of absolute descriptions. Lastly, the study of nidification is very unsatisfactory. Such defects are the cause of much error and waste of labour to the student.

Prof. Friedrich Dahl, in his guide to the birds of Central Europe, seeks to remedy these defects. It is a model of compression; its 154 pages, each fully paragraphed and subdivided, contain a very complete and well-ordered fund of data. The determination of species is the main object; the subject of life-habit is untouched. The study of nests has a section to itself. This department, naturally, is the less complete. Reference is made in every case throughout the guide to the descriptions and illustrations of Naumann.

An introductory section tabulates those crucial details of beak and pinion and claw which form the elements of classification and render the morphology of the bird unique in biology. These are well illustrated, though on too small a scale in many cases. The book is indispensable as a supplement to Naumann, and English students should make acquaintance with its method.

A. E. CRAWLEY.

Celluloid: Its Manufacture, Applications, and Substitutes. By Masselon, Roberts, and Cillard. Translated from the French by Dr. Herbert H. Hodgson. Pp. xx + 356. (London: Charles Griffin and Co., Ltd., 1912.) Price 25s. net.

THIS work, which must be judged in its English rendering, conforms with the forecast of the preface. It is a fairly complete account of celluloid manufacture, with a somewhat hesitating *exposé* of its technological basis. The authors acknowledge the collaboration of M. L. Clément in contributing (1) a theoretical study of nitration baths, and (2) a discussion of the "inflammability" of celluloid. The attendant risks of manufacture, storage, and use are treated, with full reference to the researches of Will, Vieille, Voigt, and others. Their own conclusions from the established data, in the form of "Precautions to be exercised in Celluloid Works," are practical and comprehensive.

The work is logically subdivided into:—Part i. "Manufacture," which comprises the processes involved in the production of the celluloid mass; Part ii., "Applications," deals with the production of celluloid articles, combs, handles, hollow articles, beads and buttons, and also films, including lacquers and the application of celluloid solutions in the production of filmed, or coated, and impregnated fibres; Part iii., "'Uninflammable' Celluloid and Substitutes," treats of modified celluloids, and the competing varieties of plastic colloids, such as the cellulose acetates, and xanthates (viscoid), as well as casein (galalith) and aldehyde-phenol derivatives (bakelite). In this section the authors modestly confess the insufficiency of their knowledge and information, and we shall not be thought hypercritical in remarking that this section is not to be taken "seriously."

There are unusual additions to our terminology; "pulpation" and "centrifugaliser" are instances of new words, which, however, are intelligible. But in the section dealing with the fibrous nitrocelluloses, we have "pile" (Fr. *pile*) for beater, "paste" (Fr. *pâte*) for pulp, and for the essential working parts of the beater we have "cylinder," or "drum" for roll, "slab" for bed-plate, "teeth" for bars. The general effect produced on the reader is that of *translated French*, which is not English.

The work appears at a moment which is opportune, in view of the appointment of a Royal Commission to inquire into the dangers of celluloid. The authors have dealt fully with this subject.

Atlas Photographique des Nuages. By Julien Loisel. (G. Thomas: Librairie Astronomique, Paris, 1912.) Price 18 francs.

THIS atlas contains twenty plates of beautiful reproductions from evidently very fine negatives, the size of each being $6\frac{1}{2} \times 4\frac{1}{2}$ inches. The letterpress accompanying them is extremely brief. It consists of twenty-three lines describing the methods adopted in securing the negatives, and three or four lines of description of each photograph, forming an index to the plates, in which is stated the type of cloud, general description of the formation and date of exposure.

The photographs were for the most part taken by Dr. Loisel, but they include some reproductions from negatives secured by M. L. Teisserenc de Bord, of Trappes, and by M. J. Vincent, of Uccle.

The cloud nomenclature used in this atlas is not that adopted by the International Meteorological Committee in their International Cloud Atlas, but it would have been an additional value to the present atlas if the international classification terms had been added in each case.

The photographs are so good and represent such typical clouds that the atlas should, and no doubt will, find a place not only in all meteorological institutions, but in the libraries of all interested in this fascinating application of photography.

LETTER 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.*]

The Jaw from the Stalagmite in Kent's Cavern.

It is remarkable that so little notice has been taken of the important discovery by Mr. Pengelly of a part of a human upper jaw in the granular stalagmitic layer of Kent's Cavern, and even more so that some well-known anatomists appear to have been unaware of its existence.

If the deliberate evidence of Pengelly, who for so long so carefully and scientifically explored the floor of the cave, is not to be accepted on this point, his whole investigation will be rudely shaken. It is much to be regretted that Pengelly's pamphlet entitled "The Ancient Cave Men of Devonshire," containing a most clear *résumé* of his exploration, is not better known and more easily procurable. It would be most advantageous if it could be republished. On p. 9 of this pamphlet Pengelly writes as follows:—"The objects in the *modern stalagmite* were not numerous. They consisted of charred wood, marine and land shells, remains of various mammals, including the extinct cave bear, cave hyena, tichorine rhinoceros and mammoth; well-rounded pebbles of various kinds; flint flakes, implements, and cores; and a portion of a human upper jaw containing four teeth, with a loose tooth lying near it. Some of the remains of each of the extinct animals were not only in quite the uppermost portion of the stalagmite, but were not completely covered with it. The human jaw was near its base, where it was twenty inches in thickness."

From this it is clear that extinct animals were living in Devonshire up to the very end of the period during which the upper stalagmite was being deposited; and that this must have been some considerable time after the jawbone became embedded in the lowermost layers of it.

E. A. PARKYN.

October 29.

TUBERCULOSIS AND THE MILK SUPPLY.

ATTENTION has been directed to the relationship of tuberculosis and milk, and to the problem of a pure milk supply and the methods whereby this may be ensured, by a series of articles and letters which have appeared in *The Times* during September and October. We may consider the questions thus raised under three headings: (1) how far is tuberculous-infected milk a danger to the community as a whole; (2) will pasteurisation, certified milk depôts, or other means remedy the evil if it exist; (3) can a safe milk supply be ensured without revolution in present methods.

1. The menace, if it exist, of tuberculous milk chiefly falls upon children from one to six or seven years of age, *i.e.*, when cows' milk forms a staple article of diet. There can be no risk to the breast-fed infant, but, unfortunately, the natural method of infant feeding is at present out of fashion! While it is true that tubercle bacilli have been found in some 10–20 per cent. of all samples of milk examined, and while the experiments of the Royal Commissions on Tuberculosis and of others have shown that tuberculosis may be communicated by feeding with tuberculous milk, the amount of human tuberculous infection derived from milk is still uncertain. The pulmonary ("consumption," phthisis) is the most frequent form of human tuberculosis, the death-rate per 100,000 living for 1901–1909 being 117, as against 50 for *all* other forms of tuberculosis.[1]

Now Bulloch,[2] from a very careful survey of the literature of the subject, comes to the conclusion that pulmonary tuberculosis is produced almost always, if not exclusively, by tubercle bacilli of the *human* type. More than two-thirds of human tuberculosis is, therefore, certainly not due to the *bovine* bacillus or to milk infection. Bulloch further remarks that the bovine tubercle bacillus plays a relatively unimportant rôle in the production of tuberculosis in man! But it may be objected that, inasmuch as 10 20 per cent. of milk samples contain tubercle bacilli, there must be grave risk of infection therefrom. It will be found, however, that the percentage of infected samples is much lower than this for milk obtained under reasonably good conditions, such as those under which the large dairy companies get their supplies. Again, the method of detection of the tubercle bacillus employed in the examination of milk samples is by the *inoculation* of guinea-pigs (not ingestion or feeding), after *concentration* of the bacilli by centrifuging.

Many experiments prove that inoculation is a method of infecting infinitely more certain than feeding. Probably not more than twenty tubercle bacilli are required to produce a general infection in a guinea-pig by inoculation, whereas Findel found that doses of 19,000–312,000 bovine bacilli did not infect by feeding, and Reichenbach estimated that a dose of no fewer than 140 million bovine bacilli was required to infect guinea-pigs by feeding.[3] It is well known that tubercle bacilli are scarcely ever detected by microscopical examination in mixed milk, which gives a positive result with the inoculation test; yet, if they were present in anything like the numbers necessary to infect by feeding, they should be easily detected thus, for of every 100 organisms present, 1–2 should be tubercle bacilli! The fact is, we have no data indicating the infectivity by feeding of ordinary mixed milk.

The work of the Royal Commission gives no information on this most important point, for in all their experiments on the transmission of tuberculosis by feeding, huge doses of bacilli were administered. Although, of course, every effort should be made altogether to exclude tubercle bacilli from milk, it may well be doubted if the risk of infection from ordinary mixed milk is anything like as great as has sometimes been suggested, and the expensive and harassing machinery sometimes formulated to accomplish that end would probably benefit the stockman far more than the general public.

1 Rep. Med. Officer Local Gov. Board for 1910–11.
2 Horace Dobell Lecture, 1911.
3 See McFadyean, Journ. Roy. Inst. Pub. Health, December, 1910, pp. 715 and 718.

2. Assuming that a danger of tuberculous infection from milk exists, how can it be prevented? Pasteurisation has had a great deal said in its favour, and efficient pasteurisation does destroy the tubercle bacillus. But pasteurisation, as commonly carried out, is uncertain in its action, and there are various other objections to this process. These, however, will be dealt with in another article.

"Certified" milk is another solution that has been suggested. This means that the milk is produced under stringent conditions as to cleanliness of the animals, milkers, cowhouses, milking, &c., the herds are tuberculin-tested, and the milk is cooled, bottled, and packed in ice for transit. A good deal has been said about the growth of the certified-milk-depôt movement in America, but it is not perhaps realised that this has been forced upon her populace by the deplorable condition of the general milk supply there. Moreover, certified milk, unless subsidised by public funds or private benevolence, can do nothing to help those to whom a pure milk supply is of the greatest importance, viz., the poor; for it is admitted that the cost of certified milk must be from 8*d.* to 10*d.* per quart—only a few of even the well-to-do will pay such a price! When, a year ago, the price of milk was, in stress of circumstances, raised from 4*d.* to 5*d.* per quart, what an outcry there was; and every practical dairyman knows that the consumption of milk fell off, and, what is more, has not risen again on the recent decline in price to the former level. Further, if a certified milk trade became general, enormous numbers of cases of bottles would have to be handled by the railway companies, and greatly increased truck capacity would be necessary to deal with them. These and other practical points are not always realised by the armchair reformer.

3. The great question at issue is not so much whether a very carefully dairied milk, with a low bacterial content, distributed in bottles under ideal conditions, would, or would not, be an advantage to the community as a whole, but rather whether the existing milk supply in general is the cause of such damage to the public health as is frequently so confidently asserted. Save, perhaps, as regards tuberculous infection, which, from what has been stated above, cannot be regarded as a serious menace, the general milk supply is better now than it has ever been, and it is steadily improving. Two factors, which are in the region of practical politics, would undoubtedly improve matters without revolution and unnecessary expense. These are (*a*) cooperation between the farmers in a district and the treatment of their milk (cooling, &c.) at a central depôt from which it would be distributed either to the towns around, or to the railway for forwarding to a distance by regular, fast, and properly equipped milk trains, all farms being under proper official inspection; (*b*) the elimination of the street dealer or hawker by the abolition of all station trade, and the absorption of the smaller dealers into a few large companies, so that there is but one middleman between the farmer and the consumer.

It will not be possible to speak definitely of the value of "synthesised milk," a preparation of soya beans, recently placed on the market, until its nutritional value has been ascertained.

R. T. HEWLETT.

JUBILEE OF THE PHILOSOPHICAL INSTITUTE OF CANTERBURY, NEW ZEALAND.

THE Philosophical Institute of Canterbury, New Zealand, celebrated its jubilee on August 30 by holding a conversazione in the Art Gallery, in Christchurch. The institute was established on August 30, 1862, twelve years after the foundation of the Canterbury Settlement. Sir Julius Von Haast, who had only recently arrived in the colony, was the principal leader of the movement to form the institute, and he devoted to it the remarkable energy and enthusiasm with which he founded Canterbury Museum and made it the best institution of the kind in New Zealand. He was elected the first president of the institute, and was one of its most prominent officers until his death, many years afterwards.

The institute made an excellent start on its career. It was ambitious, and it is characteristic of the spirit which animated the colonists of those days that it made up its mind at once to do something quite practical. It announced that it wished to take part in the development of the resources of the province, and to help the settlers by disseminating amongst them useful knowledge. It held its first business meeting, which was numerously attended, in November, 1862, and it listened to the reading of papers on the growth of thistles, the manufacture of the native flax (*Phormium tenax*), and other practical subjects.

Besides contributing largely to the Transactions of the New Zealand Institute, the institute has undertaken publications on its own account. Amongst these are the "Index Faunæ Novæ Zealandiæ" (1897), edited by Captain Hutton, and "The Subantarctic Islands of New Zealand" (1909), a large work in two volumes, containing reports on a scientific expedition to the Campbell and Auckland Islands, south of New Zealand. This work is the result of an enterprise which the institute took in hand in 1906, when it urged upon the Government the desirableness of extending the magnetic survey of New Zealand to the different groups of islands that lie south of the mainland. The Otago Institute gave its support, and the proposal was approved by the New Zealand Institute; and later on the scope of the scheme was extended to include investigations into the geology, zoology, and botany of the islands.

The jubilee celebration in August last was attended by a brilliant gathering. Dr. L. Cockayne, F.R.S., the president, whose researches in botany, especially in regard to ecology, are well known in the United Kingdom and other countries, and who has taken a prominent part in the institute enterprises in recent years, presided. In an address, he showed how the institute had originated, and he sketched its career; he then dealt with the position of the man of science in regard to humanity and the world's progress. He said that it is true that man does not live and move and have his being at the dictates of science, but it is to science that civilisation owes its present position, and in the thickly populated centres man's very existence depends upon the progress of science. The works of science are so wrapped up in the ordinary man's daily life that he not only does not feel grateful to the scientific man, but frequently ignores his very existence. The man in the street, in fact, although he may be well informed in other directions, forgets, or never knows, that applied science must be based upon discoveries in pure science, which at first may appear to have no importance whatever for the human race. The progress of the world depends upon the number, the quality, and the zeal of the men of science. They are the ultimate makers of the people's wealth and the rulers of the people's destinies; and they must always be highly trained and enthusiastic in their work.

The Mayor of Christchurch, in a short address, congratulated the institute, and also congratulated Dr. Cockayne on being elected a Fellow of the Royal Society. Mr. G. M. Thomson, as the representative of the Parliament of New Zealand, read congratulatory messages from the Prime Minister of the Dominion and from the Hon. R. H. Rhodes to the institute and to Dr. Cockayne as the winner of the Hector medal for his researches in botany. Mr. Thomson added that he had been asked to present to Dr. Cockayne this first Hector medal, struck in honour of the late Sir James Hector. The medal had not arrived in the Dominion, and could not be handed to the recipient just then, but it carried with it a grant to help in the recipient's future work. Dr. Cockayne's researches had cost him large sums of money, and he had great pleasure in asking that gentleman to accept a sum which would help him in the great work he still had in hand.

Dr. Cockayne returned thanks, and after other addresses had been given, the gathering was brought to an end.

PLAICE FISHERIES OF THE NORTH SEA.

THE tenth meeting of the International Council for the Study of the Sea was held at Copenhagen in April last, and the *Procès-Verbaux* have recently been published. The most important subject considered was the general report on the plaice fisheries of the North Sea, which is being prepared by Prof. Heincke, of Heligoland. Only the first section of this report was, however, ready at the time of the meeting, and it was decided that another meeting should take place at the end of September for the further consideration of the matter. The section of the report laid before the meeting by Prof. Heincke in April was based chiefly on the special market statistics of plaice landed, the greater part of the material being derived from English ports. The results of the work of the special steamers remain to be considered.

From an economic point of view the study of the plaice question is undoubtedly the most important work which the council has undertaken, and it is to be regretted that such great delay has occurred in the preparation of the report. Prof. Heincke cannot be blamed for this delay, which seems to have been due to faulty organisation on the part of the council, and to a want of appreciation of the magnitude of the task. The work might well have occupied the entire time and energy of one man with a staff of trained assistants under him, and it was clearly impossible that it could be carried out within a reasonable time, in addition to his other duties, by the director of the Heligoland Biological Station. If some of the money which has been spent on the organisation and formal administration of the Council and on the less important parts of the programme had been employed to enable Prof. Heincke to devote his whole time and energy to the task and to obtain adequate assistance in doing the detailed work, the position at the present time would have been much more satisfactory.

THE PLASTIC ART OF PALÆOLITHIC MAN.

WE learn from *The Times* of October 31 that Count Begouen, the well-known investigator of prehistoric archæology, has made a remarkable discovery in the cave known as Tus Ditboubert, in the district of Montesquieu-Aventès (Ariège), where three months ago he found mural paintings of animals, presumably of Aurignacian age. On October 10 the Count and his son broke through a mass of stalactites, and in the new gallery thus exposed found two clay figures, respectively 26 in. and 30 in. long, representing a bull and cow bison. They appear to have been attached originally to a rock, as one side is rough while the other is completely modelled. They are nearly perfect; the only damage that they had received was that one of the horns of the female bison and its tail had been broken off; the tail was, however, found on the floor of the cave. A third small clay figure was also found, but it was so roughly modelled as to make it impossible to say what it represents.

In passing through the galleries the explorers found many footprints of bears and human beings. In one of the galleries, where there was a number of otherwise indistinguishable marks on the floor, some fifty imprints of human heels were discovered, and Count Begouen, in his communication to the Academy of Inscriptions of Paris on October 30, suggested that these may represent traces of ritual observances or dances similar to those which have been oberved among the savage tribes of the present day in Australia and Africa.

This is the first time clay figures of Palæolithic date have been discovered, and it affords one more example of the wonderful finds that have been yielded by the French caves. A very large number of engravings and carvings of animals on bone and ivory have been found, as well as engravings and paintings on the walls of caves, in France and Spain; mural carvings in low relief are also known, outlines of bison traced on the clay floor occur in a cave at Niaux, and now clay figurines have come to light.

There can be little doubt that many of these works of art had what we now term a magico-religious significance. Artists are not likely to have carved, engraved, painted, or modelled in the black recesses of caves merely for the joy of expression, since few of their fellow-tribesmen would see their works of art, and then but imperfectly. The only adequate solution of the problem seems to be that these delineations and representations had a significance which was at the same time practical and religious, and it is possible that some at least of them were made for the purpose of enabling their originals to be captured, or may be, as in the case of certain Australian ceremonies, to increase their numbers; in either case, their significance would be more utilitarian than æsthetic.

NOTES.

We regret to have to announce the death of Mr. Henry Groves, at his residence at Clapham, on Saturday evening, November 2, at fifty-seven years of age, after an illness extending over many months. In conjunction with his brother James, Mr. Groves was widely known as possessed of exceptional acquaintance with the small but difficult group of the Characeæ, and the opinion of the brothers "H. and J. Groves" was constantly sought by botanists of all nations. It is understood that a volume on the British species, for issue by the Ray Society, is practically ready for the press. The most conspicuous task in which both brothers engaged was the editing of the ninth edition of Babington's "Manual of British Botany," which was in many respects remodelled, and came out in 1904. Mr. Henry Groves had served on the council of the Linnean Society some years since; at the time of his death he was again a councillor, and in certain questions he took a leading part. His death removes a loyal and devoted worker, whose place will not be easily filled.

Dr. Benjamin Boss, son of the late Prof. Lewis Boss, director of the Dudley Observatory, Albany, N.Y., has been appointed acting-director of that institution.

M. Emile Boutroux was on October 31 elected a member of the French Academy. The eminent French philosopher is honorary professor of modern philosophy at the Sorbonne, and director of the "Fondation Thiers," a residential college for post-graduate study. He is known as the author of numerous important philosophical works.

The eighty-seventh Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Sir James Dewar, F.R.S., Fullerian professor of chemistry, his title being "Christmas Lecture Epilogues." The lectures will be experimentally illustrated, and the dates and subjects are as follows:—Saturday, December 28, "Alchemy"; December 31, "Atoms"; January 2, 1913, "Light"; January 4, "Clouds"; January 7, "Meteorites"; January 9, "Frozen Worlds."

Owing to bad weather, the illuminated night flying and firework display that was to be held at the London Aerodrome, Hendon, on Tuesday, November 5, has been postponed until Saturday next, November 9. Special exhibition flights, speed and altitude tests will take place from 2.30 p.m. until dusk, and the illuminated night flying and firework display will be in progress from 7.30 p.m. until 10 p.m.

The series of lectures which the Selborne Society annually arranges will begin on November 11, when Lord Montagu of Beaulieu will preside, and Mr. Fred Enock will deal with "Fairy Flies and their Hosts." Among the subjects of other lectures are:—"Minor Planets," by Dr. A. C. D. Crommelin (January 20, 1913); "Fibres and Fibre Lore," by Mr. C. Ainsworth Mitchell (February 17); and "Byways in Biology," by Mr. James Saunders (March 3). The special children's lecture will be given by Mr. Spencer Fletcher on "Dew, Hoar-frost, and Clouds" (January 9).

The death is announced, at the age of seventy-two, of Dr. William Willard Daniells, the founder of the study of chemistry at the University of Wisconsin. In 1868 he was appointed to a chair in that institution, and established its first chemical laboratory, giving daily instruction to one student, and using an old carpenter's bench in the basement. Dr. Daniells continued in active work as the head of the chemistry department until 1907, when he became professor emeritus. He also conducted the weather bureau at the University, until this work was taken over by the U.S. Government. From 1872 to 1876 he was chemist to the Wisconsin State Geological Survey.

The Weber-Parkes prize (of 150 guineas and a silver medal), founded in 1895 by Sir Hermann Weber in memory of the late Dr. E. A. Parkes, and awarded every third year to the author of the best essay "upon some subject connected with the etiology, prevention, pathology, or treatment of tuberculosis, especially in reference to pulmonary consumption in man," has been awarded by the Royal College of Physicians to Mr. J. A. D. Radcliffe, pathologist to the King Edward VII. Sanatorium, Midhurst. The subject of the next essay, to be adjudicated upon in 1915, is an original research on the treatment of pulmonary tuberculosis with substances which are especially antagonistic to the specific organism and its products. This work must have been chiefly carried on since the year 1911. The following lectures will be given at the Royal College of Physicians during November:— Dr. Raymond Crawfurd will deliver the FitzPatrick lectures on "The History of Medicine" on November 7, 12, 14, and 19, the subject being "Echoes of Pestilence in Literature and Art"; the Horace Dobell lecture by Dr. C. J. Martin, on "Insect Porters of Bacterial Infection," will be delivered on November 21.

THE extension of the Manchester Museum was formally opened on Wednesday, October 30, by Mr. Jesse Haworth, the donor of the larger part of the cost of the new buildings, when Prof. Flinders Petrie delivered an address on the *raison d'être* for the study of Egyptology. The extension consists of a central building, 65 ft. long and 35 ft. wide, comprising basement, ground and first floors, the latter with a gallery 12 ft. wide all round. This central building is connected with the old museum by a bridge 12 ft. wide, at the level of the first floor, and, balancing the bridge in front elevation, is a low building 30 ft. long and 35 ft. wide, consisting of basement, ground and first floors, communicating with the corresponding floors of the central building. The larger room on the ground floor will be devoted to a museum of economic and applied geology, which will be practically an extension of the existing geological museum on the ground floor of the old building. The smaller room on the ground floor will contain the collections illustrative of anthropology, ethnology, and numismatics. The whole of the first floor and gallery will be given over to the exhibition of the valuable and extensive collection of Egyptian antiquities, and for those illustrating the allied civilisations of the Orient. These collections, which deal with the historic period of human development, will be directly connected, by means of the bridge, with those illustrative of Palæolithic and Neolithic man, which are exhibited on the first floor of the old museum. It has been possible, therefore, to add these important departments to the museum without any reorganisation of the existing collections, while at the same time they fall into their correct place in the general scheme of classification adopted in the museum.

FOR the third month in succession October was generally cold over the United Kingdom, although it was less so in the northern and western districts than elsewhere. At Greenwich the mean temperature for the month was 48°, which is 2° less than the average, but in both August and September the mean was more than 4° below the average. The mean maximum temperature for October at Greenwich was 57°, which is 1° below the average, and the mean minimum 39°, which is 4° less than the normal. The highest day temperature was 66°, which is the lowest October maximum since 1905. There were in all only nine days at Greenwich with the temperature above the average, and on three days at the commencement of the month the deficiency of temperature exceeded 10°. The aggregate rainfall at Greenwich for October was 1·86 in., which is 0·99 in. less than the average, and rain fell on fourteen days. The duration of bright sunshine for the month was 123 hours, which has only been exceeded twice in October in the last thirty years, and never by more than ten hours.

THE factors concerned in the ripening of cheddar cheese are discussed by Messrs. Hastings and Hart and Miss Evans in Research Bulletin 25 of the University of Wisconsin Agricultural Experiment Station. The ripening seems to be brought about first by the action of bacteria belonging to the *B. lactis acidi* group, and subsequently by that of another group of acid-forming bacteria, the *B. bulgaricus* group.

IMPORTANT studies on dietetics are being carried out by the U.S. Department of Agriculture. One of the latest bulletins (Yearbook for 1911) deals with the nutritional value of green vegetables. While they do not add greatly to the total nutrient and fuel values, they increase the wholesomeness of the diet in three ways, viz., by supplying necessary mineral matters less abundant in other food-stuffs, by supplying bulk desirable for the normal digestion of the more concentrated food materials, and by rendering the diet more varied and attractive.

A VALUABLE report on isolation hospitals, compiled by Dr. H. Franklin Parsons, has been issued by the Local Government Board. Many isolation hospitals all over the country have been inspected, and full details are given as to construction, cost, and maintenance, with plans. The utility of these hospitals is discussed, and the question of combination between adjacent authorities is considered. The architect of the Board (Mr. Kitchin) points out that the cost of a rod of stock brickwork in mortar has risen from 12*l*. 10*s*. in 1859 to 16*l*. 10*s*. in 1905 and 16*l*. 5*s*. in 1911. Suggestions are made for cheapening construction, *e.g.* by the use of steel or timber framework covered with patent slabs, which might result in a saving of 30 to 40 per cent., but this kind of construction is at present hampered by the building bylaws now in force.

THE effect of smoking on the physique of college undergraduates is discussed in a paper by Dr. Frederick J. Pack in *The Popular Science Monthly* for October, under the title "Smoking and Football Men." The author's reason for singling out football men for special study is that it is impossible to draw definite inferences from comparing students some of whom are athletes and some of whom are scholars, and, on the other hand, he considers that the football squad forms a very nearly homogeneous group on which observations can well be based. Further collections of statistics are given referring to the effects of smoking on scholarship as tested by examinations, and to the lung capacities of smokers and non-smokers. In every case the evidence is against smoking. In the football trials only half as many smokers as non-smokers were successful. In the case of able-bodied men smoking was associated with diminished lung capacity amounting to 10 per cent. Finally, in examinations it was found that about 70 per cent. of the candidates obtaining highest marks were non-smokers, while 70 per cent. of those obtaining lowest marks were smokers.

IN *The Nature Photographer* for October Mr. F. J. Koch gives an interesting photograph of a herd of chamois in the Alps, taken with a telephoto lens.

DR. C. C. HOSSÉUS, of Berchtesgaden, has favoured us with a copy of a paper from the *Nachrichtsblatten der Deutschen Malakozoologischen Gesellschaft* on land and marine shells collected during an expedition to the Malay Peninsula and Siam. The most important result appears to be the evidence of the molluscan fauna that the islands of Koh-Si-Chang and Koh-

Kam-Yei formerly constituted a portion of the Siamese mainland.

In a paper on the origin of asymmetry in Cetacea published in vol. xli. (pp. 45–54) of the *Anatomischer Anzeiger*, Prof. G. Steinmann argues that the horizontal tail-fin of that group has been produced by torsion from the perpendicular type characteristic of the Mesozoic saurians. As the author believes cetaceans to be a convergent group derived from three of the Mesozoic marine reptilian orders (Ichthyosauria, Plesiosauria, and Thalattosauria), it is, to say the least, not a little curious that a similar torsion of the tail-fin should have occurred in each group. The same author has also sent us a copy of a pamphlet, by himself, published by Engelmann, of Leipzic, and entitled "Die Abstammungslehre, was sie bieten kann und was sie bieten."

The interesting and rare fresh-water alga *Phaeothamnion confervicolum* has recently been found near Edinburgh by F. L. M'Keever, who describes (Trans. Bot. Soc. Edinburgh, vol. xxiv) the first recorded appearance of this plant in Great Britain. The genus Phæothamnion has by the majority of recent systematists been placed at the base of the brown algæ, and may be regarded as one of the intermediate forms in the ascending scale of brown organisms arising from the Flagellata with brown chromatophores (Chrysomonads), and giving rise to the true brown algæ (Phæophyceæ), hence it is a type of special interest from the phylogenetic point of view. Hitherto this genus has been found only in Sweden, Germany, Austria, and Italy. As the alga disappeared from Mr. M'Keever's cultures before its zoospores could be carefully studied, it is to be hoped that the plant will be found again, and further investigations made in order to determine its systematic position and affinities with greater certainty.

Prof. W. E. Ford has edited the thirteenth edition of "Dana's Manual of Mineralogy" (New York: Wiley and Sons, 1912, price 8s. 6d. net), which continues to be one of our best elementary text-books. The photographic illustrations of actual specimens, printed as separate plates, are distinctly helpful. As is usual in the smaller works on mineralogy, crystallographic considerations remain somewhat loosely stated. The problem of isomorphism outside the cubic system is not touched on in the three pages devoted to the subject, and the statement on p. 11 that "in general the ratio of the intercepts of a crystal face upon the crystallographic axes can be expressed by whole numbers or definite fractions" is surely, in this abbreviated form, misleading. Useful tables for the determination of minerals occupy nearly seventy pages.

The Deutsche Seewarte has added another lustrum (1906–10) to the valuable results of the meteorological observations made at the stations of the second order under its control. The lustra previously dealt with cover the thirty years 1876–1905, and some of the former have already been combined into longer periods, *e.g.* in 1904 the results included the twenty-five years 1876–1900. The observations are made at 8h. a.m., 2h. and 8h. p.m., local time, and excepting at two stations, where the English-pattern (Stevenson) screen is used, the thermometers are installed outside suitable windows. The results are calculated for months, seasons, and the year.

A lengthy article (in Japanese) on observations of air currents appears in the Journal of the Meteorological Society of Japan (xxxi., No. 7, 1912). The author, Mr. Sato Junichi, describes some experiments which he carried out in January and February last on the summit of Mount Tsukuba (2925 ft.), both with small hydrogen balloons, known as "pilots," and with pyrotechnic balloons. The latter, devised by himself, are balloon-like firework pendants, which are released at various heights, determinable from the nature and quantity of explosives used. It is claimed that whereas "pilots," being released at ground-level, are at the mercy of surface winds from the start, the firework balloons are carried through the lower strata and begin their journey several hundred metres high. For the observation of these balloons the author uses a special form of theodolite, also designed by himself, provided with a sighting attachment and a plummet, and costing only a few pence. In the experiments referred to, when comparative observations were made with both types of balloon, air currents in the opposite direction to those at ground-level were found at heights of from two to five hundred metres. Details are given of numerous observations, the information obtained embracing speed and direction of air currents, the location of upward and downward eddies in the atmosphere, height of surface currents, &c. The meteorological conditions, nature of clouds, force and direction of the wind prevailing on each occasion are also given.

In recording observations of periodic phenomena, it is very usual to make a certain number of groups of regular observations and to take the arithmetical mean of each group. In a note on the application of the method of harmonic analysis (Journal of the Meteorological Society of Japan, xxxi., 5), Mr. Y. Tsuiji shows that when the results are used for the purposes of harmonic analysis the coefficients thus obtained are too small, and formulæ and tables are given for the necessary corrections.

Under the title "Surfaces of Revolution of Minimum Resistance," Dr. E. J. Miles, writing in the Bulletin of the American Mathematical Society, discusses the form of an airship or other figure of revolution which experiences the least resistance in its motion through a resisting medium. The assumption made is that the pressure on any surface element is a function of the inclination of that element to the direction of motion, and is unaffected by the currents set up by the remaining portions of the surface, and in this respect the problem differs essentially from that presented by an airship or body moving through a material fluid medium. The problem is, however, a classical application of the calculus of variations dating back to the time of Newton.

A series of articles on the origin of the earth's magnetic field have appeared in *Terrestrial Magnetism* during the last two years from the pen of the editor of that journal, Dr. L. A. Bauer. The subject has been recently dealt with by Prof. Schuster in his address to the Physical Society of London, and by Dr. W. F. Swann in the July number of *The Philosophical Magazine*. The conclusion to which each examination leads is that none of the present theories offers a satisfactory explanation of the earth's magnetic state. In the September number of *Terrestrial Magnetism* Dr. Bauer shows that if the mean values of the magnetic elements be calculated for successive parallels of latitude between 60° N. and 60° S., these values are represented to within 1 per cent. by an expression for the magnetic potential which involves only the first and third zonal harmonics; that is, it involves the first and third powers only of the cosine of the colatitude. This fact serves as a very severe test of any theory advanced, and none of them appears capable of surviving its application.

An interesting paper on the occurrence, analysis, and genesis of iridosmine obtained from the New Rietfontein Mines is communicated by Mr. C. Baring Horwood to vol. xv. of the Transactions of the Geological Society of South Africa. Iridosmine is an intimate mixture of iridium and osmium, found in small quantities, as small grey particles, associated with gold. Specimens microscopically examined by the author showed a decidedly crystalline character, but the metal has never been recognised *in situ* or in hand specimens; "panning" experiments show that in the New Rietfontein it chiefly occurs in a very narrow banket reef, known as the carbon leader, wherein the gold is always associated with carbon. Spectroscopic analyses, made for Mr. Horwood at the Solar Physics Observatory, South Kensington, indicate that the iridosmine is mainly composed of osmium, ruthenium, and iridium. A concentrate examined quantitatively at the Imperial Institute had a specific gravity of 19, and contained 95 per cent. iridosmine, of which 45 per cent. was iridium. The metal does not occur in paying quantities, and it took six months to collect 910 grains at the Rietfontein Mine, during which period 102,800 tons of ore were treated, and more than 52,500 oz. of fine gold were recovered. Mr. Horwood concludes that these metals of the platinum group are certainly of secondary origin, formed as primary segregations by magmatic concentration in the basic eruptives of the mines, and extracted from the dykes by active superheated gases during the pneumatolytic phase of eruptive activity. Probably, at a later stage, hydrothermal action was an important factor in concentrating them in the banket reefs.

Attention may be directed to an article on isomerism by Werner Mecklenburg in *Naturwissenschaftliche Wochenschrift* for October 20. The article, which extends over ten pages, and occupies the larger part of the issue, deals with the phenomena of position isomerism, optical isomerism, stereo-isomerism, and dynamic isomerism, together with the Walden inversion and the isomeric derivatives of cobalt and other metals as investigated by Werner.

We have received from Messrs. A. Hermann et Fils a reprint of a series of lectures "Sur quelques Thèmes choisis de la Chimie Physique pure et appliquée," delivered by Prof. Arrhenius at the University of Paris from March 6 to 13, 1911. Some of the subjects are identical with those of the Silliman lectures delivered at Yale in 1911 and published recently under the title "Theories of Solution"; this statement applies to the lectures on molecular theory, on suspension and the phenomena of adsorption, and on free energy. But different ground is covered by the lectures on the atmospheres of planets and the physical conditions of the planet Mars. The five lectures cover 112 pages, and are issued at the modest price of three francs.

The yearly memorandum issued by Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, deals with the relative costs of burning fuel or oil under boilers, and exploding oil or gas in engines. With the ruling prices of oil, it will not be profitable to burn it in preference to coal until the price of the latter has risen to 38*s*. per ton; but oil can be profitably used in internal-combustion engines whenever and wherever the price of coal exceeds 15*s*. per ton. The greater part of the memorandum deals with the valuable experiments of Profs. Heyn and Bauer on corrosion, or rather on the influence of about forty dissolved salts in reducing or increasing corrosion. The phenomena associated with corrosion are too erratic to permit of definite conclusions being drawn, but Mr. Stromeyer gives an excellent analysis of the experiments mentioned which will be of great service to steam users who are troubled with corrosive feed waters.

We have before us twenty-two volumes belonging to the series "Aus Natur und Geisteswelt," published by the firm of Mr. B. G. Teubner, of Leipzig and Berlin. The series now includes nearly four hundred volumes dealing with many aspects of literature, art, music, history, law, philosophy, science, and technology. The price of each volume is one mark, or 1.25 marks in cloth covers. A distinguishing characteristic of the series is the attention given to present-day problems. Among the subjects of recent volumes, for instance, are directions of modern physics, experimental cytology, regeneration, biochemistry, milk and its products, problems of modern astronomy, astronomy in relation to practical life, surgery of our time, practical mathematics, spinning, light-railways, wireless telegraphy, aërial navigation, brewing, and kinematography. Each volume is simply written and suitably illustrated, and the whole series forms a remarkably comprehensive collection of manuals of modern thought and progress. Both the editor and publisher are to be congratulated upon the production of the volumes, which should do much to promote interest in science, art, and letters among German readers.

A new issue of the list of second-hand microscopes and other instruments which they have on sale has been issued by Messrs. Clarke and Page, 23 Thavies Inn, Holborn Circus, London, E.C.

A catalogue of works on anthropology, ethnology, primitive society, &c., also mythology and folk-lore, including a portion of the library of Sir H. H. Risley, K.C.I.E., has just been issued by Mr. Francis Edwards, 83 High Street, Marylebone, London, W.

A SECOND edition of Mr. A. H. Mackenzie's "Theoretical and Practical Mechanics" has been published by Messrs. Macmillan and Co., Ltd. The first edition was reviewed in our issue of May 16, 1907 (vol. lxxvi., p. 50). While the general character of the book has been preserved, the new edition has been much enlarged, and in its preparation Mr. Mackenzie has had the cooperation of Mr. A. Forster. The price of the volume remains 1*s*. 6*d*.

OUR ASTRONOMICAL COLUMN.

A NEW COMET, 1912*c*.—A telegram from the Kiel Centralstelle announces the discovery of a new comet by M. Borrelly at Marseilles on November 2. The position at 7h. 39·9m. (Marseilles M.T.) was:—

R.A. = 17h. 47m., decl. = 38° 57′ N.,

which lies about 2° N.W. of θ Herculis. The motion is said to be south-east, the magnitude 10, and the comet transits at about 3 p.m.

A second telegram from the Centralstelle states that the comet was observed by M. Abetti, at the Arcetri Observatory, on November 3, when its position at 7h. 7·6m. (Arcetri M.T.) was:—

R.A. = 17h. 55m. 12·8s., decl. = 37° 21′ 5″,

and the magnitude was estimated at 9·5. The position, at present, is favourable for observations during the evenings, when the comet is fairly high up in the north-west sky.

GALE'S COMET 1912*a*.—Photographic observations made at the Hamburg Observatory, Bergedorf, on October 9 showed the coma of Gale's comet to be elongated in the direction of the chief tail, position angle 79°, and to be about 1·1′ in diameter; a plate taken with a 5-inch objective of 25-inch focal length showed a tail 5·4° long, which was 2′ broad until it reached about 1° from the head, and then broadened out to 11′ at a distance of 5°. A shorter tail emerged in position angle 122°, and another was suspected at position angle 50°; the magnitude of the whole comet was about 5·5.

Spectrographic observations on October 10 and 15 showed a bright image of the head at 387 $\mu\mu$ ±, and the bands at 474 and 563 $\mu\mu$, the blue band being essentially brighter than the yellow; the band at 516 $\mu\mu$ was much fainter. The continuous spectrum was much fainter than the bands named, but could be seen extending right along the spectrum from 387 to 563 $\mu\mu$, and was brightest between 397 and 410 $\mu\mu$. Prof. Schwassmann states that on the whole the spectrum obtained is very similar to that given by Kiess's comet at the beginning of July, 1911. (*Astronomische Nachrichten*, No. 4608.)

SCHAUMASSE'S COMET 1912*b*.—In No. 4609 of the *Astronomische Nachrichten*, M. Fayet shows that if the comet recently discovered by M. Schaumasse is not identical with Tuttle's comet, the two objects are moving in very similar orbits. If the identity is accepted, there is an error of about 5° in the mean anomaly, and nearly 4″ in the mean motion, according to M. Raht's elements for Tuttle's comet as given in these columns last week. A tentative calculation by M. Fayet does not indicate the near approach of the comet to any great planet during the recent revolution, and he suggests the possibility that the comet may have split up, the object discovered by M. Schaumasse being only one part. It would be of interest to search for the main body near the calculated positions given in M. Miličevič's recently published ephemeris; on October 20 the position of comet 1912*b* was α = 10h. 3m., δ = -0° 43′, whereas the ephemeris position for Tuttle's comet was α = 9h. 37m., δ = +73° 27′.

In a later note (*Astronomische Nachrichten*, No. 4610), M. Fayet states that he finds that near the end of 1900 Tuttle's comet was near Jupiter, the minimum distance being 0·8, and a rough calculation gives October 9, 1912, as the resulting date of perihelion passage, three months earlier than the date indicated by the 1899 orbit; the new value for the mean motion (μ) is 263·94″. M. Fayet concludes that the identity of 1912*b* with Tuttle's comet is very probable, but his hurried calculations of the Jovian perturbation are necessarily only approximate. M. Schaumasse's new ephemeris gives the following positions and distances:—

Ephemeris 12h. (M.T. Paris).

1912	α h. m.	δ ° ′	log r	log Δ
Nov. 7	10 54·5 ...	−22 2		
11 ...	11 6·7 ...	−26 27 ...	0·0371 ..	0·1040
15 ...	11 19·1 ...	−30 41		
19 ...	11 31·9 ..	−34 39 .	0·0536 ...	0·1218

SUNDIALS.—Several interesting articles on sundials are published in the October number of *L'Astronomie*. M. Roguet describes an elaborate dial recently erected on the south façade of Juvisy Observatory, and also discusses the history of this instrument, which he believes was invented about 550 B.C.; this article is illustrated by several interesting photographs and diagrams, the former depicting a large number of ancient, or especially interesting, dials. M. d'Aurelle Montmorin describes the "Auto," a new portable sundial, and M. Joyeux gives an interesting and detailed description of the sundial erected on the communal school at Sèvres.

VARIABILITY OF SOLAR RADIATION.—Mr. C. G. Abbot, director of the Smithsonian Astrophysical Observatory at Washington, has just returned from a five months' astronomical expedition to Bassour, Algeria. The object of the expedition was to confirm or disprove the supposed variability of the sun. The Astrophysical Observatory has been for seven years making observations on Mt. Wilson, in California, on the daily quantity of heat received from the sun. The observations are arranged in such a manner as to indicate not only the quantity of solar heat reaching the earth, but also the quantity of heat which would reach a body like the moon, which has no appreciable atmosphere.

The observations have indicated that the sun is probably a variable star having a range of variation amounting to from 5 to 10 per cent. within an irregular interval of from five to ten days. Last year Mr. Abbot observed in Algeria, while his colleague, Mr. Aldrich, observed on Mt. Wilson, in California. The object of thus duplicating the measurements was to avoid being misled by any local atmospheric conditions which might have affected Mt. Wilson observations. As nearly one-third of the circumference of the earth lies between Mt. Wilson and Algeria, it could not be expected that a similar local disturbance could affect both stations on the same day in the same manner. The observations of 1911 supported the belief that the sun is variable, but owing to cloudiness their number was not sufficient fully to establish this point. Hence it was thought best to return to Algeria this year.

The observations made by the Smithsonian party in Algeria this year were apparently very satisfactory. They occupied sixty-four days, and on more than fifty of these days Mr. Fowle made similar observations on Mt. Wilson, in California. The results of the work of 1911 and 1912 are expected to establish the supposed variability of the sun, or to show conclusively that this hypothesis can no longer be held.

OPENING OF THE NEW LABORATORIES OF BACTERIOLOGY AND PUBLIC HEALTH OF KING'S COLLEGE, LONDON.

THE completion of the arrangement by which primary and intermediate medical studies at Charing Cross Medical School are transferred to King's College, and the public health staff at King's College is afforded accommodation in their place, was marked on October 31 by the formal presentation of the laboratories by Prof. Simon Flexner, on behalf of the Medical School Committee, to the University of London, King's College.

Mr. H. A. Waterhouse presided, and in an introductory speech Dr. William Hunter, the Dean of Charing Cross, traced the development of the scheme, and suggested that the new laboratories would forward the ideal of Huxley, namely the progress of biological science.

Prof. Flexner expressed his pleasure at being present, for in so doing he considered that he would be helping the progress of public health, a science the knowledge of which is essential in all great cities, and especially in London. He spoke of the interest with which this science is regarded in America, and of the large sums of money given in order to forward research in that country, and expressed the hope that England, from whom America has learnt so much, might now follow her example in this respect.

The Hon. W. F. D. Smith (treasurer of King's College) expressed his agreement with Prof. Flexner's remarks, and said he was convinced that this day was a great one in the history of public health. He referred to the monumental skill and energy of Dr. Hunter, which had made the opening of the laboratories possible. The day, he argued, marked a stage in the policy of concentration which he was sure was a right one, as leading to a saving in labour and expense. The new laboratories would be used for research and for post-graduate teaching.

Dr. Headlam (principal of King's College) emphasised the advantages of this policy of reciprocity both to Charing Cross Hospital and to King's College. He supported a policy of concentration because he thought there was danger of money being squandered on new buildings which were not always needed. He reviewed the foundation of the Bacteriological Laboratory in 1887 by Dr. Edgar Crookshank, the first professor, and announced that Prof. Crookshank had presented his valuable library to the department. Their hope was that in time they would build up a fitting institute of hygiene within the University.

Sir Henry Miers (principal of the University) pointed out the need there was for willing cooperation of all available forces within the University, and held that Charing Cross and King's College had given a real example of what could and ought to be done in London.

The new laboratories and several structural and other improvements at the Charing Cross College were afterwards inspected by a large number of visitors.

PROBLEMS IN INFECTION AND ITS CONTROL.

THE Huxley lecture was delivered at Charing Cross Hospital (where Huxley studied) by Prof. Simon Flexner, director of the Rockefeller Institute, New York, who took as his subject "Some Problems in Infection and its Control."

After a reference to Huxley's work and to his Baltimore lecture in 1876, the lecturer alluded to the fact that we are still ignorant of the causes of several important infective diseases, and after quoting the example of scarlet fever, proceeded to discuss the biological investigation of poliomyelitis, or infantile paralysis.

This disease occasionally occurs in epidemic and pandemic form, and arose in America in the Atlantic coast cities and other places which receive the emigrant population from Europe. On clinical grounds it had been regarded as infectious, but this remained uncertain until Landsteiner and Popper in 1909 found that it could be transmitted to monkeys by intraperitoneal injection of matter taken from the spinal cord of a fatal human case. This method of transmission is, however, an uncertain one, but if intracerebral inoculation be substituted, the disease is transmitted with certainty to monkeys. No parasite, bacterial or protozoan, can be detected in the diseased tissues microscopically, and it is found that the filtrate from an emulsion of the infected cord, filtered through a porcelain filter, is capable of infecting; the organism, therefore, is ultra-microscopic. Some eighteen diseases are now known the micro-parasites of which are ultra-microscopic or invisible with the best optical appliances; these include yellow fever, rabies, and vaccinia.

The virus of poliomyelitis is resistant to drying, light, and chemical action. Animals which recover from the disease are immune from a further attack. The poliomyelitis virus can be detected only in the central nervous system, in the mucous secretion of the nose and throat, stomach and intestine, and in the mesenteric glands—nowhere else. The virus probably gains access to the body by the nose and thence to the brain *via* the olfactory nerves. Carriers, either healthy and unaffected persons, or slight and abortive cases, exist, and serve to transmit the disease. It has been suggested that insects may help to spread the disease, but at present there is no evidence of this, though the virus remains active in the bed-bug for some days. Nor is there any evidence that the domestic animals spread the disease. Proof has been given that the sporadic (*i.e.* isolated or scattered) cases of infantile paralysis are caused by the poliomyelitis virus by the fact that the blood of these children contains the same immunising substances as are present in the epidemic form of the disease, and in inoculated monkeys. There appear to be biologically different strains of the poliomyelitis virus. Attempts have been made to devise a chemo-therapy for the disease, and urotropin, a drug which has some antiseptic action and is secreted into the cerebro-spinal fluid, has been found to be of some value in preventing infection experimentally.

METEOROLOGY IN SCOTLAND.

MR. A. WATT contributes to the Journal of the Scottish Meteorological Society (vol. xv., No. xxviii.) a valuable discussion of the mean annual rainfall of Scotland. The discussion is accompanied by a table giving for 594 stations the mean annual rainfall and the number of years used, and for 129 of the stations for which records for forty years were available the amount of the maximum and minimum annual rainfall and the years of their occurrence. 1872 appears to have been for Scotland, as for Great Britain as a whole, the wettest year, and 1887 the driest. A map showing the distribution of mean rainfall over Scotland, based upon the values given in the table, forms the frontispiece to the volume. The region of greatest rainfall is near to the west coast, north of the Caledonian Canal, where the width of the high ground from west to east is relatively small, so that east winds as well as west winds can contribute to the rainfall before they have precipitated their moisture on other mountain ranges.

Mr. Watt contributes also an interesting note on the early days of the society, from which we learn that the society was contributing meteorological reports to the Registrar-General for Scotland so long ago as 1856. We note also that for a short period in 1858 the late Prof. Everett was the secretary of the society.

Dr. Aitken gives an account of some experiments on radiation temperatures. The black-bulb thermometer has always been regarded with some suspicion as possessing some of the qualities of a toy and some of a scientific instrument. The fact that a sheet of white paper, held near the bulb on the side away from the sun, produced a rise of temperature of 37° F. will give additional weight to the arguments of those who would relegate the instrument to the toy category. A very valuable result for meteorologists with grass minimum thermometers is Dr. Aitken's discovery that a piece of blackened metal tube slipped over the upper end of the thermometer prevents condensation of spirit in the upper part of the tube.

Among other contributions may be mentioned Dr. Mossmann's discussion of the climate of Chile, including some valuable tables of monthly rainfall and temperature, and Prof. Knott's review of Pernter and Exner's "Meteorological Optics," in which he ably defends the Ben Nevis observers against Pernter's criticism that they repeatedly sought for colours in their observations of optical phenomena.

The Journal includes tables giving the monthly meteorological statistics for about seventy places in Scotland, and a very valuable table of monthly rainfall at about 500 stations. According to the accounts published on p. 358 of the Journal, the collection of these statistics and the publication of the Journal have been carried out at a cost of less than 500*l.*, including all the expenditure incidental to the operations of the society.

THE FOURTEENTH INTERNATIONAL CONGRESS OF ANTHROPOLOGY AND PREHISTORIC ARCHÆOLOGY.

THE fourteenth Congress of Anthropology and Prehistoric Archæology met at Geneva on September 9–14, with a total registered membership of 555. The previous congress was held at Monaco in 1906. Since that date, numerous and important discoveries which deserved careful presentation and discussion in open session have been made throughout the world.

The congress met, in general sessions, in the Aula, or Lecture Hall, of the University of Geneva, whilst a number of lecture-rooms and halls were placed at its disposal by the federal and cantonal authorities, who spared no pains or money in helping to make the meetings a decided success. There was an honorary committee of ten, including Forrer, the President of the Swiss Republic, and Henry Fazy, President of the State Council of the Republic and of the Canton of Geneva, an executive committee of thirty eminent men of science, with Edouard Naville, hon. president; Dr. Eugène Pittard, president; Dr. Emile Yung and Alfred Cartier, vice-presidents; Dr. Deonna, secretary; Albert Lombard, treasurer; together with a distinguished *commission de réception*, comprising Théodore Bret, State Chancellor of Geneva, Chapuisat, Fatio, Favre, and Reverdin, the whole forming the machinery of the congress.

The following countries were officially represented by delegates:—*Germany*, Prof. Felix von Luschan; *United States of America*, Dr. Alès Hrdlička, Dr. Charles Peabody, and Prof. G. Grant MacCurdy; *South Australia*, Mr. Ramsay Smith; *Austria-Hungary*, Prof. M. Hoernes and Dr. Bela-Posta; *Belgium*, Baron de Loë and Prof. A. Rutot; *Cuba*, Prof. L. Montané; *Spain*, Prof. Manuel Anton-Férrandez and Prof. L. de Hoyos-Sainz; *France*, Prof. Marcelin Boule, Prof. Cartailhac, Dr. L. Capitan, and Prof. R. Verneau; *Mexico*, Señor Genaro Garcia; *Algeria*, M. Joly; *Monaco*, Prof. Marcelin Boule; *Roumania*, Prof. Tsigara-Samurgas; *Sweden*, Prof. O. Montélius.

Besides, there were official representatives or delegates of 163 scientific bodies and universities from Germany, United States of America, Argentina, Austria-Hungary, Belgium, Brazil, Canada, Egypt, Spain, France, Great Britain (England, Scotland, and Ireland being represented), Italy, Japan, Mexico, Portugal, Roumania, Russia, Sweden, and Switzerland, together with 392 unattached members of the congress from the above-mentioned countries, besides Denmark and Uruguay, who constituted the whole membership of the congress.

By a majority vote at the first session, French was made the official language of the congress, but verbal communications or papers before the congress could be presented in English, French, German, or Italian. Spanish was also added by a majority vote at a later session.

At the opening session of the congress, in the name of the Federal Council of Switzerland and of the State Council of Geneva, M. H. Fazy extended a hearty welcome to all the members present. Prof. Pittard recalled the 1866 meeting of the congress held at Neuchâtel, in conjunction with the fiftieth annual meeting of the Swiss Society of Natural Sciences. Prof. Giovanni Capellini, the venerable professor of geology in the University of Bologna, one of the founders of the congress, and sole survivor of the first meeting at Spezzia in 1865, replied to the address of welcome on behalf of the visiting delegates.

Upwards of 200 papers, read in full or in abstract, were presented by nearly as many congressists, a number altogether too great for fair treatment and discussion in open session. It was agreed that forthcoming congresses be divided into sections dealing with (1) *La pierre*; (2) *les métaux*; and that the last two days of the meetings be devoted to (3) *anthropology*.

Space will not allow us to do justice to the character of the papers presented and subjects discussed. Among the papers of wide interest to anthropologists and archæologists may be mentioned that of Prof. Marcelin Boule, director of the Institute of Human Palæontology, recently established in Paris, on the subject, *Homo neanderthalensis*. A thorough diagnosis of this ultra-human species was given by that eminent master of vertebrate palæontology. Of all the recorded specimens illustrating remains of this species available to the student of anthropology, there exist only twenty truly authentic. Neanderthal man was short in stature, with long face, bulky head, primitive characters of dentition, verticality complete, nose salient (ultra-human). *Homo neanderthalensis* goes out and disappears after the Middle Pleistocene. In the architecture of his cranium he does not resemble the short-faced Australian Bushman, as suggested, who, on the contrary, is *one* with Europeans. *Homo neanderthalensis* is *one* with the chimpanzee, and represents an archaic type, constituting in all probability a stage or phase in the series or evolution of *Homo heidelbergensis*.

Discussing the value of human palæontology, Prof. Boule stated that this new science had already taken man out of his zoological isolation and placed him in the front rank of a company of varying types constituting a human branch of vast proportion. We were far from having, as yet, a complete palæontological series of the genus Homo. In closing his remarks Prof. Boule paid a tribute to the excellence of the work done by British investigators in the field of anthropology, among others noting Huxley and Lankester.

In Victoria Hall, and under the presidency of M. S.

Reinach, of the Institut de France, Prof. O. Montélius, the distinguished delegate from Stockholm, gave an interesting lecture on Italy and Central Europe during the Bronze age. Prof. Montélius surveyed the influences of Etruscan art and industry as they spread northward from the Alps to the Baltic, especially at the time when amber became an important article of commerce. A comparative study of the various weapons, daggers, knives, and blades used previous to the evolution of the sword proper was presented by means of diagrams and photographs projected on the screen, showing the gradual spreading of the Italian influence northward. Traces of Mycenian (Greek) articles were also present in the collections covering the same period.

On Friday evening, September 13, "Cave Man" formed the subject of Prof. Cartailhac's public lecture, held in the same hall, under the presidency of Dr. Felix von Luschan, of Berlin. Prof. Cartailhac limited his observations to Palæolithic man and his culture as revealed in the discoveries made during more recent years. The artistic skill of prehistoric man was practically unknown up to 1895, when the savant Rivarré directed attention to the great importance of the discovery made in 1880 by M. Sotisla and his little daughter in the Santander cave. Some *forty* caves and more have since been searched and carefully studied by Abbé Breuil, M. Capitan, and the lecturer, who illustrated his remarks by means of lantern slides showing engravings, as well as pictures in line and colour, depicting various hunting scenes, in which the bison, reindeer, elephant, horse, and bull played a conspicuous part. Mural decorations included pictures illustrating archers, impressions of hands on the cave walls, together with figures of men and women, made by the remote occupants of these caverns.

A question radically affecting the chronology of the Stone age was raised by Mr. Reginald Smith, of the British Museum, on the strength of certain resemblances noticed between worked flints found on the surface of the chalk area and those of the Aurignacian period from caves in France.

Abbé Breuil, who has just visited England, gave a description of recent excavations in the Castillo cave in Spain. Fifty feet of accumulated deposits in the cavern had been carefully examined, and various stages determined above the base—three Aurignacian levels, and one *typical* with bone implements, followed by three Mousterian layers, separated by variant materials and stalagmitic deposits. Near the junction of these two series a warm fauna was found; then four Magdalenian levels with materials, separated by stalagmitic layers, below which came a Solutréan layer. Several hundred specimens were obtained, amongst others nests of worked quartzite implements.

References were made to the timely and generous foundations by his Serene Highness Prince Albert of Monaco of the chair of human palæontology in Paris, and to his achievements in the science of oceanography. Prince Albert, as is well known, has undertaken at his own expense the publication of the volumes describing and illustrating prehistoric man and his habitations, not only in the south of France and in Italy, but also in Spain. Several references were made to the Institut de paléontologie humaine recently established in Paris as an international institute, with Boule, Breuil, Obermaier, Verneau, Manouvrier, and others attached, marking a new era in researches pertaining to man.

A marked result of the last two congresses, held in Monaco and Geneva, is found in the earnest desire to gather together none but the most accurate information on the subjects dealt with. All materials collected and discovered in caves, tumuli, &c., must be treated as so many geological or palæontological specimens. Their precise mode of occurrence, relative position, and condition of deposition, together with a close record of all factors bearing upon the problems presented in each individual instance, must be ascertained and records made without bias or prejudice.

The Museum of History and Art of Geneva, containing valuable collections in archæology, was visited, and a reception held in its magnificent halls. The collections are admirably displayed and carefully classified. A State banquet, a reception at L'Ariana, and a garden-party at Prof. Naville's gave the congress opportunity to meet Genevans "at home."

Besides an excursion round the lake and to Chillon Castle, archæological excursions were organised by the committee to a number of lacustrine and other stations of prehistoric interest. The Station de Treytel at Bevaix and the Station de la Tène at Préfargier were visited on Monday, September 16. On the Tuesday and Wednesday following, the Museums of Bâle and Zurich (the National Museum) were visited, and their excellent collections examined. On Wednesday excavations were made in "the tumuli of Grueningen," for the benefit of the excursionists, whilst the next two days were spent in Lucerne and Berne, where the well-known anthropological and historical museums are located, the party returning to Geneva by way of Lausanne, where the historical museum proved of much interest in its collections from prehistoric sites.

Spain figured conspicuously at the congress, not only in the attendance, but also in the importance of papers presented, dealing with the wealth of recent discoveries made in that country. Following a strong representation and invitation to the congress on the part of the Marquis de Cerralbo that Spain be selected as its next place of meeting in 1915, a strong feeling in favour of that country was openly expressed. Italy withdrew its application for the fifteenth congress. It was rumoured that an anthropological or ethnographic congress will "take shape" in 1914 in the city of Washington, the membership and adherents thereto to be called together for 1916. Strong representation was made by officers and members of the fourteenth congress, held in Geneva, to consolidate and reduce the number of congresses rather than divide them.

The best side of a congress lies in the opportunities it affords men to meet and discuss outstanding problems. Much time seems to be wasted in listening to papers presented by congressists and read at breakneck speed, as these can be read to greater advantage when published. It was in the halls and lobbies of the University of Geneva, in quiet nooks and corners, alongside the numerous exhibits, and even at private functions and public receptions, that groups of two, three, and more, met one another, compared notes, became better acquainted with methods and means, discussing questions of special interest, and unravelling knotty points.

THE SCIENTIFIC THEORY AND OUTSTANDING PROBLEMS OF WIRELESS TELEGRAPHY.*

If we have two media of different dielectric constants in contiguity, and if a line of electric force crosses the boundary, then it is well known that the conditions to be fulfilled are that the tangential component of the electric force on either side of the boundary must be continuous, and also the normal component of the electric displacement or flux must be continuous. This involves a refraction of the line

* Introductory remarks by Prof. J. A. Fleming, F.R.S., at a joint discussion by Sections A and G of the British Association at Dundee. Continued from p. 268.

of electric force in crossing the boundary. It is bent away from or towards the normal, and if K_1 and K_2 are the dielectric constants and θ_1 and θ_2 the angles the line makes with the normal, then

$$K_1 \cot \theta_1 = K_2 \cot \theta_2.$$

The law of refraction of light is

$$\mu_1 \sin \theta_1 = \mu_2 \sin \theta_2.$$

Hence, in the case of light, the velocities of the rays in the two media respectively are proportional to the sines of the angles of incidence and refraction. In the case of the electric force, the velocities are inversely as the square roots of the tangents of the angles of incidence and refraction of the lines of electric force.

If, then, we consider a Hertzian oscillator which is partly in one medium and partly in another of greater dielectric constant, there will be a distortion at the boundary of the loops of electric force which are thrown off at each oscillation. If the upper medium is air and the lower medium is a material of greater dielectric constant, then corresponding to a normal semi-loop of electric force or air, there will be a completing semi-loop in the other material which is sheared backward, as shown in Fig. 1. If in the air at the boundary surface the force is normal to the surface, it will not be normal just below that surface in the medium of greater dielectric constant. It will have a longitudinal component. As the oscillations take place, these longitudinal components of the force are periodic in space and time, and constitute the surface wave which is similar to the electric waves produced on wires.

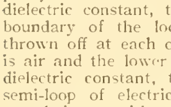

FIG 1.

If the earth were a perfect conductor, say, a ball of copper at the absolute zero of temperature, these surface waves would be confined merely to the surface skin. In the case of the actual earth, even sea water is a sufficiently poor conductor to allow the penetration of the surface wave to some little depth in it. Although the "numerical distance" is small, it is not so small as to extinguish altogether the surface wave.

The objection has been raised (see Dr. Eccles, *The Electrician*, April 5, 1912, vol. lxviii., p. 1064) that no experimental proof has been given of the actual existence of Sommerfeld's surface waves. Against this it should be noted that Sommerfeld has carefully explained that the surface waves are not separated sharply from the space waves, and may be regarded merely as a particular distribution of the moving electrostatic field near the common surface of the air and earth and accompanying electric currents in the earth. It is easy to prove that we can have surface electromagnetic waves on a *sheet*, similar in nature to electromagnetic surface waves on wires, of the existence of which we have abundant experimental proof. An argument in favour of the existence of these surface waves may perhaps be derived from the experience that high antennæ do not seem necessary for the *reception* of signals, even over long distances, thus indicating that there is a concentrated electric and magnetic field near the surface of the earth.

P. Epstein has delineated from Sommerfeld's equations a portion of the field of electrostatic force round an oscillator placed first over a perfectly conducting earth, and, secondly, over an earth of finite conductivity.[10] In the first case the loops of lines of electrostatic force are seen to terminate perpendicularly on the earth, and are divided symmetrically by the surface plane. In the second case they are distorted so that the lines at spaced intervals do not terminate perpendicularly. If, however, they have a component parallel to the earth's surface this is equivalent to a combination with a true space or Hertzian wave of a surface wave, similar to the electric waves on wires, which latter can travel along the guiding surface, irrespective of curvature of that surface.

If these conclusions are valid there is nothing to prevent the surface waves going half round the earth. It may, therefore, be quite possible to communicate by radio-telegraphy direct from England to New Zealand. There is one matter which may be of importance. Since the surface waves started from any one point reach an antipodal point by different paths it may be that unless the position of the receiving station is rightly selected, interference will arise between surface waves reaching it by different lengths of path, and hence extinction of signals for some places but not others in the same region. According to this theory, then, we need not endeavour to explain long-distance radio-telegraphy by diffraction, because true space waves are very little concerned with it.

We pass on then to consider the next question, viz. the influence of the nature of the surface in radio-telegraphy—why, for instance, it is conducted with certain wave lengths so much more readily over sea than land.

This matter has been particularly considered by Dr. Zenneck in an interesting paper. Assuming for the sake of simplicity a plane earth and plane electromagnetic waves, he discusses the effect of the conductivity and dielectric constant of the earth's crust on the wave propagation.[11]

Starting from the same equations as Sommerfeld, he arrives at an expression which enables him to calculate the damping of the waves along the horizontal boundary surface. He shows that this damping is determined by the dielectric constant and conductivity of the earth's crust. He calculates the distance the plane wave must travel before its amplitude is reduced to $1/\epsilon$ of that at the transmitter, and exhibits the results for various values of the dielectric constant and conductivity in the form of curves. Waves 1000 ft. in length over a sea surface would travel 10,000 km. before reduction to $1/\epsilon$ in amplitude, but over very dry soil only for 10 km. or less. The analysis shows that there is a considerable penetration of the wave into dry soil, but into so good a conductor as sea water the penetration is at most a metre or two. Moreover, Zenneck shows that over sea surface the lines of electrostatic force terminate nearly perpendicularly to it, but over a dry surface this is not the case. There is then a considerable rotating component, and the direction of the electric force is represented by the rotating radius vector of a semi-ellipse, the major axis of which slopes forward in the direction in which the wave is travelling. Zenneck's results have been extended by F. Hack, who has shown that underground moisture has the same effect as surface moisture in preventing degradation of amplitude.

The general result of these investigations, compared with practical experience, is to show that we can by no means consider the earth to be a perfect conductor in the case of radio-telegraphy, but that it has an extremely influential action in degrading the amplitude of the waves deforming the travelling electrostatic field, and in creating a type of surface wave which

[10] See P. Epstein, "Kraftliniendiagramme für die Ausbreitung der Wellen in der drahtlosen Telegraphie bei Berücksichtigung der Bodenbeschaffenheit," *Jahrbuch der Drahtlosen Telegraphie*, vol. iv., p. 176, 1910. Epstein has, however, only delineated the field in the air. He ought to have indicated the nature of the field just below the surface in the sea or earth, as well as to show the refraction of the lines of force at the surface.

[11] J. Zenneck, "Ueber die Fortpflanzung ebener elektromagnetische Wellen langs ebenen Leiterflache und ihre Beziehung zur drahtlosen Telegraphie," *Ann. der Physik*, vol. xxiii., p. 846, 1907. This paper was freely translated, with expository notes by J. A. Fleming, entitled "The Function of the Earth in Radio-telegraphy." See *Engineering*, June 4 and 11, 1909.

attenuates much less fast than a pure Hertzian wave and can travel round the curvature of the earth quite easily.

On the whole, we may say that the theory, as given by Zenneck and Sommerfeld, is a valuable attempt to bridge over the very serious gap in our knowledge of the reasons for certain well-ascertained facts in radio-telegraphy. Nevertheless, there are still unexplained difficulties.

Another unsolved problem in radio-telegraphy is the explanation of the effects of the atmospheric conditions and daylight upon it.

The suggested explanations are in many respects imperfect. In the earliest days of radio-telegraphy it was found that atmospheric electric discharges produced irregular and false signals, which sometimes greatly interfered with working. These were more objectionable at the time when the receiving instrument was a coherer of some kind associated with the Morse printer. Nowadays, when the reception is by telephone, it is usual to have the spark frequency at the sender high enough to give a shrill note in the telephone. The receiving operator can then distinguish, to a great extent, between the clear musical note of the right signals and the lower squeaks or grunts in the telephone due to atmospheric discharges. Nevertheless, at certain times and in certain regions the so-called atmospherics present serious obstacles to radio-telegraphic communication.

When we turn to the effect of sunlight on the propagation of radio-telegraphic waves, which was discovered and described by Mr. Marconi in 1902, we find that even after ten years we are still, intellectually speaking, very much in the dark as to the reason for this daylight effect.

The first observation made by him in 1902 was that by night signals could be received over sea from the Poldhu station at a distance of 2099 miles, whereas by day the same kind and type of signal ceased to be detectable at about 700 miles; also that at the time when the sun rose over the sending station the signals at 700 miles' distance quite quickly became very weak.[12]

Of recent years he has noticed that in the morning or evening, when the boundary between light and darkness occurs, about half-way across the Atlantic signals sent across become weak.

Also he has noticed that in sending with a coupled transmitter radiating waves of two wave lengths, whereas the longer wave length is the one generally received, there are certain periods at sunrise and sunset when the shorter wave gives the best signals.

It has also been pointed out, both by Mr. Marconi and G. W. Pickard, that soon after the time of sunrise at the sending station there is a very pronounced decrease in the strength of the signals received a few hundred miles', or at some considerable distance from a power station, but that after sunrise there is a partial recovery of strength. There is also a gradual rise in the strength of the signals soon after sunset, and a very pronounced maximum value after or about midnight. An interesting curve has been given by Prof. Pierce in his book on "Wireless Telegraphy," p. 135, taken from Pickard's observations showing the general variation of the strength of received signals at a distance of 600 miles from the Marconi station at Glace Bay during the hours of the day and night. It appears that the current in the receiving telephone at midnight was about thirty times greater than by day. Confirmatory observations have been published by the Telefunken Co.

[12] See G. Marconi, Proc. Roy. Soc. Lond., June 12, 1902. A note on the effect of daylight upon the propagation of electromagnetic influences over long distances.

Two theories have, so far, been proposed to explain this effect:—

1. The original suggestion of Mr. Marconi (which has been tentatively adopted by Prof. Zenneck) was that it is due to the effect of light in discharging the sending antenna, so that it does not reach at each oscillation such a high potential by day as in darkness.

2. The theory that the daylight effect is due to the ionisation of the air by sunlight giving it increased conductivity, and so producing absorption of the electric waves.

Neither of these theories seems to meet all the facts. If the daylight effect were an action of light on the sending antenna alone, it should be produced independently of the distance of the receiving station, whereas it is essentially a cumulative or long-distance effect.

Again, so far as measurements of the electric conductivity of air have been made, they do not give support to the theory that the daylight effect is due to air conductivity produced by ionisation, because measurements of this conductivity show it to be too small to account for the observed wave attenuation.

Prof. G. W. Pierce has made calculations which show that the air conductivity would have to be 100,000 times greater than it actually is to account for even a part of the observed effect at 3000 km. distance.

Prof. Zenneck also agrees that atmospheric conductivity by ionisation cannot account for the phenomena.

Let us, in the first place, consider theoretically the propagation of an electromagnetic wave through a medium possessing dielectric constant (K) and conductivity (σ).

It is quite easy to obtain an expression for the absorption coefficient of such a medium. Starting from the Maxwellian equations as above, we have the quantity denoted by k on a previous page defined by the equation—

$$k^2 = \frac{\mu K p^2 + j4\pi\mu\sigma p}{c^2},$$

since k is a complex, it can be represented by $k = \alpha + j\beta$.

Hence we have—

$$\beta^2 = -\frac{\mu K p^2}{2c^2} \pm \sqrt{\frac{16\pi^2\sigma^2\mu^2 p^2}{4c^4} + \frac{\mu^2 K^2 p^4}{4c^4}},$$

and if $\frac{\sigma}{pK}$ is a small quantity, as it is when the conductivity is small and the frequency $p/2\pi$ is large, we have then—

$$\beta = \frac{2\pi\sigma}{c\sqrt{K}}.$$

If we consider a plane wave the amplitude of which varies as $\epsilon^{j(kx-pt)}$, it attenuates in amplitude to $1/\epsilon$ of its initial value in travelling a distance—

$$\frac{1}{\beta} = \frac{c\sqrt{K}}{2\pi\sigma}.$$

If ρ is the resistivity in ohms per c.c., then $\rho = (9 + 10^{11})\sigma$, and we have—

$$\frac{1}{\beta} = \frac{\rho\sqrt{K}}{60\pi}.$$

We can therefore determine at once the absorption effect of any conducting dielectric of which the resistivity in ohms per c.c. and the dielectric constant are known. Thus, supposing the dielectric constant is 9, and the resistivity 500 megohms per centimetre cube, the value of $1/\beta$ would be nearly 80 km., or fifty miles. This is, then, the distance in which the wave amplitude would be reduced to about one-third of that at the origin. It is clear, therefore, that to propagate waves for any considerable distance through the earth's crust the specific resistance would have to be as high as 1000 megohms per c.c. Also it is evident that unless the resistivity of the air as produced by ionisation is less, say, than 20,000 megohms per c.c., or considerably less than 10^{20} electromagoetic units, the ionisation cannot be the cause of the daylight absorption.

I believe no one has observed so low a resistivity for air near the earth's surface, or even a thousand feet up, as 10^{19} C.G.S. electromagoetic units per c.c. The point, however, requires further investigation.

On certain assumptions this atmospheric resistivity can be determined by elevating a captive balloon to the required level by a wire, and measuring the potential of the balloon when the wire is insulated, and also the current flowing through the wire when the wire is earthed. The ratio of the current in amperes to the potential in volts gives us the total conductivity S of the air. If C is the electrical capacity of the balloon, and if σ is the conductivity of the air, then it can easily be shown that $S=4\pi C\sigma$ (see J. A. Fleming, "Principles of Electric Wave Telegraphy and Telephony," second edition, p. 725). Accordingly $\rho=4\pi C/S=4\pi CI/V$, where I is the total electric current flowing along the wire to the earth, and V is the potential of the balloon.

Some useful measurements of this kind made by Messrs. A. J. Makower, W. Makower, W. M. Gregory, and H. Robinson, in 1910 ("An Investigation of the Electrical State of the Upper Atmosphere made at Ditcham," see Quarterly Journal of the Royal Meteorological Society, vol. xxxvii., October, 1911) showed that the total resistance from a certain kite at a height of 1400 ft. on a certain day was 1000 megohms. Assuming a kite capacity of 100 electrostatic units, this corresponds to a resistivity of the air equal to $12{\cdot}5\times10^{11}$ ohms, which seems rather small. A plane electric wave would, however, have to travel nearly 60,000 km. in the air to have its amplitude reduced to 1/E. Hence even this conductivity is not enough to account for the observed attenuation by daylight of long radio-telegraphic waves.

Unless, therefore, there is very much greater atmospheric conductivity than one billionth of a mho (1 bimho) per c.c. at or about 1000 ft. or so above the earth's surface, it does not appear as if air conductivity caused by ionisation due to ultra-violet light could account for the diminished amplitude of radio-telegraphic waves during daytime.

The careful measurements of the air conductivity at various heights, and at various hours of the day and night over sea and land, would give us valuable data for further testing this matter.

Sommerfeld suggests that the daylight reduction is due to the increase in the value of the coefficient k for the air by the production of conduction due to ionisation. The effect of this is to increase the value of the "numerical distance," and therefore to reduce the intensity both of the surface and the space waves. He supports this view by an observation made by Ebert, who states that he measured the conductivity of the air in brightest sunshine at a height of 2500 m. during a balloon ascent and found it to be twenty-three times greater than at the ground level.[13]

It is possible that some part of the effect may be due to actions taking place quite close to the sending antenna. This view may be supported by the interesting observations made during the nearly total solar eclipse on April 17 last, on the effect of the temporary diminution of daylight on the strength of radio-telegraphic signals.

[13] See *Ann. der Phys.*, vol. v., p. 721, 1901.

Whilst visiting the Eiffel Tower station at Paris, Commander Ferrié, who is in charge of this station, informed me a slight increase in the strength of the signals at distant receiving stations had been noticed at the time of greatest observation of the sun at Paris.

Also in Denmark, Mr. H. Schledermann stated in a letter to *The Electrician* that observations made between the Royal Dockyard station in Copenhagen and the Blaavands Huk Lighthouse on the North Sea, at 300 km. distance, showed that during totality the signal strength was increased.

Also in England, Dr. Eccles noted an increase in the strength of atmospheric strays and signals from Clifden observed in London during greatest obscuration. These observations show that even a partial diminutioo of the sun's light is sufficient to increase the strength of radio-telegraphic signals, possibly by an action on the air between the stations, and especially on that near the transmitting station.

I suggest that it would be well worth while to erect temporary transmitting stations on and off the line of totality during the future total solar eclipses, for the purpose of observing the effect on radio-telegraphic signals sent out from them to other receiving stations.

Another possible explanation of this daylight diminution has, however, occurred to me which I should like to submit to you. It is well-known that sound is better heard when the wind is blowing from the source to the observer than when it blows in the opposite direction. It is also known that there are curious vagaries in sound transmission whereby loud sounds are heard sometimes better at great than at short distances. These effects were explained by Sir George Stokes as due to the fact that the velocity of sound is greater when moving with the wind than against the wind. Now, owing to friction and other causes, the velocity of the wind is generally greater at a height above the earth's surface than at the ground level. Hence, if a sound wave is travelling outwards from a centre against the wind, the upper parts move more slowly than the lower parts of the wave front, and hence the ray direction is tilted up and the sound passes over the observer's head.

The suggestion I venture to make is that when the upper layers of the air are ionised, the ions act as condensation nuclei for water vapour, and the presence of these numerous water spherules gives the upper air a larger dielectric constant.[14] Therefore an electric wave moves more slowly in it than in non-ionised air. Hence, if a plane wave is moving parallel to the earth's surface and the upper layers of air are ionised by light, the greater velocity of the wave front at the lower levels causes it to slope backwards and the direction of the ray is elevated, so that it may pass over above the receiving antenna and not affect it.

Accordingly, if in the upper region of the air the ionisation of the air by ultra-violet light increases the dielectric constant so as to retard slightly the wave velocity, the wave front would be tilted backwards and at long distances the waves might pass so far above the receiving antenna as to weaken very greatly the signals.

This tilting up of the ray will occur when the ionisation of the upper air has taken place over a part of the interval between the stations. It will be most pronounced when the greatest difference exists between the dielectric constant at the earth level and that at the level a few miles up in the air. At very large distances, say 2000 miles, an extremely small

[14] See Sir J. J. Thomson, "Conduction in Gases," p. 217, who says that air exposed to ultra-violet light may be regarded as full of extremely minute drops of water.

difference in the dielectric constant of the air at low and at high levels would be sufficient to give the wave front a sufficient tilt to make the waves pass far above a receiving antenna 200 ft. high, and so weaken immensely the received signals because the effect is cumulative, and noticeable therefore only at very great distances. As an experimental contribution to the subject I have made some preliminary observations on the dielectric constant of air filled more or less with damp steam or warm mist. A tubular condenser was constructed of such kind that steam from a small boiler could be blown between the tubes, and the tubes were so supported that the condensation of the steam could cause no loss of insulation. The electrical capacity of this condenser was determined carefully by the Fleming and Dyke capacity bridge, using a telephone as a detector, and alternating currents having a frequency of 2760.[15] Employing all necessary precautions, and comparing the dielectric constant taken as unity of air nearly saturated with water vapour, with air having water globules or damp steam in it, we found that the dielectric constant of air filled with water spherules varied from 1·026 to 1·004, according to the amount of damp steam present in the space. In other words, an electric wave would travel more slowly in the steam-impregnated air than in the ordinary saturated air in the ratio of 980 to 1000, or 998 to 1000, or anything between these limits.

If, then, we consider a plane electromagnetic wave travelling with plane vertical and its lower end in ordinary air and its upper end in air containing minute water spherules, the upper end would travel more slowly than the lower, and the wave front would acquire a backward tilt sufficient, in a distance of a few hundred miles, to carry the wave right above an ordinary receiving antenna. If the ionisation of the upper air by ultra-violet light results in the production of condensation nuclei, which condense water vapour round them, then it is highly probable that the upper levels of the air have a slightly greater dielectric constant than the lower, and a difference of even a very small fraction of 1 per cent. will be cumulative in its action on the wave in giving the wave front a backward tilt in travelling over long distances.

Mr. Marconi states that over the Atlantic he has found the maximum daylight effect to occur when the shadow boundary was about half-way across the Atlantic, the sending station being in daylight and the receiving station in darkness. I think the well-known "sunrise nick" in the signal intensity curve is due to the fact that the effect is at a maximum when the greatest difference exists between the state of the upper air as regards ionisation and that near the earth. Later in the day convection currents arise to churn up the air and bring it more into a homogeneous condition, which, whatever may be the state of ionisation, is unproductive of any tilt in the wave front.

It has been frequently suggested that an explanation of long-distance radio-telegraphy may be found in the reflection of the electromagnetic waves at the under surface of a layer of ionised air in the upper atmosphere. No proof, however, has been given that this hypothetical layer of ionised air has a sufficiently defined surface to cause wave reflection. Hence, it is improbable that anything like copious reflection of long electromagnetic waves could take place at the under surface of a layer of ionised air producing an inverted mirage effect. This point, however, is one open for discussion. It is true that refraction may produce a change of ray direction which simulates reflection, as in the case of the phenomenon of the mirage. In this case the intense heat of the earth expands the layer of air next to it, and lowers its refractive index. Hence, the lower end of a plane wave of obliquely incident light travels faster than the upper end, and may do so to an extent sufficient to swing the ray right round, as if it were reflected from the layer of heated air. For a similar effect to occur with radio-telegraphic waves, it would be necessary for the upper end of the wave front to travel much *faster* than the lower end. In other words, the upper end must be in a region of less dielectric constant than the lower end.

Since the above remarks were put in type, a valuable paper has been published by Dr. Eccles (see Proceedings Roy. Soc., vol. lxxxvii. A, p. 79, 1912, on the diurnal variations of electric waves occurring in nature, and on the propagation of electric waves round the bend of the earth), in which a theory is developed of electric wave propagation in ionised air. He gives a mathematical proof that under certain assumptions as to the mass ot these ions the wave velocity would be increased as compared with that in un-ionised air, and hence that a plane vertical wave front travelling with lower end near the earth and upper end in air more or less ionised by sunlight would be caused to lean forward by the increased velocity of its upper end. Hence he proves that, according to wave length and circumstances, the wave may be better able to follow round the earth's curvature, or may be prevented from doing it.

On this basis he has developed a theory of long-distance radio-telegraphy and of the inhibition of daylight upon it. The chief criticism to which I think his theory is open is that he assumes that the dielectric constant of the air is unaffected by the ionisation or condensation of water vapour on these ions. This is not absolutely certain. We know that in the case of ionisation, such as dilute solutions in a state of ionisation, such as dilute solutions of metallic hydrates in water, the dielectric constant of the solvent is considerably increased. As a rule, anything which increases conductivity in a dielectric increases also the dielectric coefficient. Hence ionisation may do so in the case of air. If the dielectric constant (K) is increased by ionisation, then in the expression given by Dr. Eccles for the wave velocity that velocity may be more reduced by this increase in K than it is increased by the presence of the ions.

It would seem, therefore, most necessary to settle by experiment whether the wave velocity is increased or diminished by the presence of the inns due to ultra-violet light before we can base a theory upon the constancy of the dielectric coefficient.

There is no doubt, however, that the earth's atmosphere contains something which acts at times towards radio-telegraphic waves like a fog or mist towards light waves.[16]

There are also occasions of unusual transparency when waves of 300 or 600 metres in length seem to travel round the world in an extraordinary manner. Ships provided with the ordinary ship transmitters and receivers occasionally pick up signals sent 1000 miles away. This is not due to special operative skill but to a temporary transparency of the atmosphere to radio-telegraphic waves.

The next question to which I should like to direct attention is to the present state of the theory of directive antennæ. I need not go very fully into the early history. Mr. Marconi pointed out in 1906 the special qualities of an antenna consisting of a long wire arranged so that part is vertical, but the greater

[15] For a description of this bridge and method of using it, see the paper by J. A. Fleming and G. B. Dyke, on the power factor and conductivity of dielectrics for alternating electric currents of telephonic frequency and at various temperatures, Journ. Inst. El c. Engineers, 1912.

[16] Interesting observations have been made on this matter by Admiral Sir Henry Jackson, F.R.S. See Proc. Roy. Soc., Lond., vol. lxx p. 254, 1902.

part horizontal, and that radiation takes place most energetically in the opposite direction to which the free end of the horizontal wire points.[17] Also by the law of exchanges a bent antenna which radiates unequally absorbs unequally in different azimuths. The question is as to the explanation of the action of this bent antenna.

In 1906, starting from a suggestion by Sir Joseph Larmor, I gave a theory based on the view that the bent antenna is equivalent to a combination of an open and closed circuit and assumed the earth to be a perfect conductor. The objection has been raised to this theory that it implies that the directivity should fall off with distance.

Experiments have not yet been made, so far as I am aware, on a sufficiently large scale and at sufficiently great distances to settle this point, and the experimental problem is undoubtedly complicated by the effect of the nature of the soil surface over which the waves travel in different dielectrics or regions. Nevertheless, Mr. Marconi's experiments show that the directivity persists for several hundred miles. Recently the problem has been discussed by H. von Hoerschelmann in the *Jahrbuch der Drahtlosen Telegraphie* (see vol. v., p. 15, 1901). According to his theory, the effect of a bent antenna is entirely due to vertical electric currents which are produced in the earth just under the horizontal part of the bent antenna. Hence the directivity depends on the conductivity of that region of the earth.

Starting from the same system of equations as Sommerfeld, he obtains expressions for the vector potential or Hertzian function which show that the function which determines the vertical field in the earth and in the air is dependent on the azimuthal angle, in such manner that there is no directivity if the earth is a perfect conductor, but that if the earth has a finite conductivity under the antenna then an unsymmetrical radiation takes place and the directivity, once created, persists even though the waves travel out later on over a good conducting surface. The mathematical work in Hoerschelmann's paper needs careful consideration by pure mathematicians to test whether the transformations of the Besselian functions he employs are valid and his analysis correct. He points out that as a consequence of his theory a bent antenna situated over a sea surface should not have the same degree of directivity as one situated over a poor conducting soil. These conclusions could easily be checked experimentally.

The general result of all the theoretical investigations of Zenneck, Sommerfeld, and Hoerschelmann is to show that the function of the earth in radio-telegraphy is by no means confined merely to guiding a space wave, but that it fulfils a most important function in assisting to create surface waves and in permitting earth currents which have directive effect. Recent experiments with antennæ laid on the ground or under the ground by Dr. Kiebitz have directed attention afresh to the matter, although many of Kiebitz's results seem only a repetition of those obtained by Marconi in 1906 with antennæ laid on the ground or a little above it.[18]

Kiebitz used as receiving antennæ wires carried on insulators placed in ditches about one metre deep. The ends of the wires were earthed through condensers. The receiving appliance was at the centre.

By such antennæ properly oriented he found he could receive signals from all the principal radio-telegraphic stations in England, France, and America.

There is no need to assume that these received waves are propagated through the deep strata of the earth. The effects are exactly what might be expected from waves travelling over the surface.

The chief interest of Kiebitz's experiments lies in the confirmatory proof they give that an elevated antenna is not necessary for *reception*. On the other hand, for long-distance *transmission* an elevated aërial wire or one raised above the earth is requisite.

The chief problem yet to be faced in connection with sending antennæ is to find a form of antenna which will radiate a large power, say, 100 to 500 kw., at a relatively low frequency or long wave length consistently with high antenna efficiency.

There is room for an immense amount of research yet on improved forms of antenna. When we consider that the function of a sending antenna is something like that of a gas mantle or gas-fire radiator, viz. to transform into radiation of desired wave length as large a fraction as possible of the supplied energy, and remember what has been done in the corresponding luminous problem, it is easy to see that countless questions of great practical value in connection with antennæ for radio-telegraphy remain unsolved.

The ingenious methods of directive telegraphy due to Bellini and Tosi deserve mention, and suggest that, in the case of wireless plant erected on ships means for instantly locating the direction of the arriving waves is a matter of the greatest importance. Although the practical problem is to some extent solved, there is room for further invention in connection with it.

We can scarcely leave this discussion without some mention of the state and prospects of wireless telephony.

The essential condition of success in transmitting speech is the possession of means for creating undamped oscillations or alternating currents a frequency not less than 20,000. When the Poulsen arc generator was first introduced it was hailed as a solution of the problem, but practical experience has shown that whilst experimental feats can be performed with it, it has not the simplicity and ease of manipulation required for commercial work. The modification recently introduced by Mr. E. L. Chaffee, consisting of a copper-aluminium arc in damp hydrogen, the arc being formed between two closely adjacent plane surfaces, appears to be an improvement. The practical solution seems, however, to be in the perfection of some simple, easily managed form of high-frequency alternator. The ingenious inventions of Goldschmidt in utilising the properties of the polyphase motor to increase frequency have been developed by the Lorentz Company of Berlin, and seem likely to result in the production of a practical form of extra-high-frequency alternator suitable for radio-telegraphy and radio-telephony in a practical high-frequency machine.

In addition to the generator, inventors have wrestled with the difficulties of making a microphone transmitter which shall be able to carry a large current without heating. To conduct wireless telephony over any distance we have to modulate in accordance with the wave form of the speaking voice a very large antenna current. The problem has to some extent received solution in the liquid microphone of Majorana, the relay microphone of Dubilier, and a recently invented heavy-current microphone of Rühmer.

We seem to be, however, on the track of mechanical means for generating undamped oscillations and microphonic means for modulating them, and wireless telephony is therefore even now a practical matter

[17] See G. Marconi on methods whereby the radiation of electric waves may be mainly confined to certain directions, etc., Proc. Roy. Soc. Lond., vol. lxxvii., p. 413, 1906.

[18] See Dr. F. Kiebitz's "Recent Experiments on Directive Wireless Telegraphy with Earthed Antennæ" *The Electrician*, March 8, 1912, vol. lxviii., p. 868.

for a few hundred miles of distance. It is quite within possibility it may yet be conducted across the Atlantic.

As regards other inventions, we are still in want of more simple means for recording telegraphic messages. Since the coherer fell out of use the reception is mostly conducted by ear. Somewhat elaborate photographic methods, suitable for large land stations which employ the Einthoven string galvanometer, have been introduced, but what is still required is a means of calling up the operator and of recording the message on board ship which is at least as sensitive as the telephone plus the human ear, for ordinary shipboard communication.

The receiver current is, however, very small, and available power is at most a few microwatts in the form of a current of a few microamperes.

There are, therefore, innumerable practical and scientific problems in connection with radio-telegraphy which await solution. These require mathematical, physical, and radio-telegraphic knowledge of a high order to overcome them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. F. R. MILLER has been appointed lecturer in physiology in McGill University, Montreal.

THE bequests provided by the will of the late Mr. Thomas Bartlett, of Liverpool, include one of 20,000*l.* to the University of Liverpool for the purpose of establishing scholarships of the value of 40*l.* per annum for engineering students.

AT its meeting on October 28, a letter was read by M. Liard to the council of the University of Paris from Mr. Andrew Carnegie, offering to the University the last 4000*l.* necessary for equipping the new Institute of Chemistry, in course of erection in the Rue Pierre Curie, Paris.

THE Royal Agricultural College, Cirencester, having been recognised as the centre for advisory work in forestry in the counties of Cornwall, Devon, Somerset, Gloucestershire, Wiltshire, Monmouthshire, Herefordshire, and Worcestershire, Prof. H. A. Pritchard has been appointed technical adviser, and Mr. A. D. Hopkinson lecturer in forestry and forest mycology. The vacancy caused by the promotion of Prof. R. G. Stapledon to the post of research botanist at University College, Aberystwyth, has been filled by the appointment of Mr. C. B. Saunders (London), who has for some years been lecturer in biology at Holmes Chapel Agricultural College.

PROF. A. KULIABKO, of the University of Tomsk, Siberia, informs *The Times* of the inauguration at Tomsk, on October 20, of an institution, founded by the munificence of Peter Makoushin, which aims at the instruction on a large scale of the people of Siberia. The institution in question is called the House of Science, and is meant to be a popular university, where anyone may obtain instruction, from the elementary to the secondary standard, free of charge. It includes also a section for instruction of the kind usually given at universities. The institution will give hospitality to the conferences of teachers in elementary schools; it will contain a library to be used free of charge; special evening classes will be held; while the dissemination of knowledge of sanitation and hygiene will have a leading place in the programme. A museum of practical knowledge and many other means of instruction will render the Tomsk House of Science a boon to Siberia.

THE calendar of the University of Sheffield for the session 1912–13 provides another striking example of the efforts being made by the authorities of modern universities to keep in close touch with the educational needs of the industrial centres in which they are located. At Sheffield, for instance, in addition to the comprehensive faculty of pure science, there is a faculty of applied science, in which, under suitably arranged conditions, the degrees of bachelor, master, and doctor of engineering, or bachelor, master, and doctor of metallurgy, can be secured. Students who for various reasons do not graduate in the faculty of applied science may, by attendance at day or evening classes, on complying with the regulations, secure an associateship in engineering or in iron and steel metallurgy. In mining and architecture, too, diploma courses have been arranged. It is interesting to note that arrangement has been made with the Imperial College of Science and Technology by which the University of Sheffield is recognised as being in association with the Imperial College for such of their students as may desire to specialise in the study of the metallurgy of iron and steel for the associateship of the Royal School of Mines. To meet the special needs of women a two-years' course of work in the University and the Sheffield Training College of Domestic Science has been inaugurated, and a diploma in domestic science is awarded to successful students at the end of the course. While the applied subjects are encouraged so successfully, the other departments of university work are in no way neglected, and the faculties of arts, medicine, law, and so on, are equally complete.

THE council of King's College, London, has received from the Rev. A. C. Headlam the intimation of his intention to resign the office of principal and dean of the college at the end of the present year. In the House of Commons on Monday, Sir E. Cornwall asked the President of the Board of Education whether his attention had been directed to the letter from the Rev. A. C. Headlam to the Bishop of London, dated October 11, in which Dr. Headlam alleged, as one of the reasons for his resignation, peremptory and arbitrary action on the part of the Board in requiring the removal of the college to another site; and whether he would state on what ground the Board had made such requirement without first consulting either the college or the Senate of the University on the subject. In reply, Mr. J. A. Pease said:—"I have seen the letter referred to. The Board have expressed their concurrence with the opinion of the Advisory Committee on University Grants that the present site of King's College does not admit of such extension as will enable the college to take its proper place in the University. The Board have indicated their readiness to receive a deputation from the Senate of the University of London upon the question of site, but apart from this they have taken no action in the matter, and they have made no requirement. There is no foundation whatever for the charges of discourtesy and peremptory and arbitrary action contained in the letter referred to. The Board and their Advisory Committee have no intention of interfering with the conditions of freedom and independence which are necessary to enable a university to perform its proper functions."

THE Government of India recently decided, we learn from *The Pioneer Mail*, that the time had come to endeavour to connect Indian educational institutions more closely with business firms, railways, and other employers of labour, to inquire how the former can better meet the requirements of the latter, and to point out the way to further employment of Indians in them. For this inquiry Colonel Atkinson and Mr. Dawson were selected as having special practical experience. They have completed their investigations and issued a report. The great need which the report emphasises is that education should be made more practical, not only in technical institutes, but also in primary and secondary schools. Among special recommendations made in the report, the following may be noted:—(1) That the present system under which State technical scholarships are granted to Indians for education in technical institutions in England and elsewhere should be discontinued. That suitable stipends should be granted to Indians who have completed successfully their theoretical and practical education in India to enable them to be apprenticed for practical experience with firms of repute in England. (2) That minor technical institutes should be placed under the control of one central institution in each province. (3) That the education of skilled workmen should only be carried up to vernacular reading, sufficient elementary arithmetic for accounts and sufficient knowledge of drawing to understand a dimensioned sketch. (4) That the most promising method of training skilled workmen is to establish manual training schools for children in big centres and near big workshops; the boys to be apprenticed in workshops from the ages of twelve to fourteen years. During the apprenticeship they are to be obliged to attend afternoon classes to complete their literary education, and finally to obtain some theoretical knowledge of their work.

SOCIETIES AND ACADEMIES.

LONDON.

Institution of Mining and Metallurgy, October 17.—Mr. Edward Hooper, president, in the chair.—J. W. **Ashcroft**: The flotation process, as applied to the concentration of copper ore at the Kyloe Copper Mine, New South Wales. As a consequence of the oxidised ore at this mine being practically exhausted, the original method of treatment was found to be inadequate, and the present management introduced an experimental flotation process with the view of obtaining a better recovery and higher grade concentrate. As first planned, the plant for this flotation process was divided into a grinding section and a flotation section, and the paper deals at length with the defects which manifested themselves in the first experimental stages, and with the rearrangements dictated by experience. The chief defects were the excessive amount of oversize in the feed of the stirring boxes, the excessive dilution of the pulp, the irregularity of the overflow from the flotation chambers due to the irregularity of the feed and of the speed of the impellers, and a want of proper means to control the supply of oil. To remedy these, the grinding pans were altered to the positive feed type, and were arranged to discharge on to revolving screens, so as to keep the feed to the flotation machine more even in size; the pulp thickener was moved and placed between the screens and the flotation machine so as to keep an even feed to the stirring boxes and to regulate its density; the flotation machine was controlled by a sensitive governor to keep the speed of the stirrers constant, and an apparatus was devised to secure an even flow of oil. The results of this reorganisation proved satisfactory, and this paper gives interesting details of costs of operation, &c., and some observations on the successful working of the process.

Physical Society, October 25.—Prof. C. H. Lees, F.R.S., vice-president, in the chair.—Prof. H. **Nagaoka** and T. **Takamine**: The constitution of mercury lines examined by an echelon grating and a Lummer-Gehrcke plate. The authors have photographed the principal lines of mercury, using an echelon spectroscope crossed by a Lummer-Gehrcke plate. They find that the 5790 line consists of eight, the 5769 line of four, the 5461 line of nine, the 4359 of eleven, the 4078 of six, and the 4047 of seven components, the positions of which in general agree with those found by recent observers. They point out a simple relation between the distances of the components from the principal line in each case, and a further relation between the quotient of each of these distances by the wave-length of the principal line, which holds for all the lines.—Prof. H. **Nagaoka**: Note on the mutual inductance of two coaxial circular currents. Methods are given for the rapid calculation of the mutual inductance of two coaxial circular currents. Maxwell's first formula is converted into theta-functions, and then expanded in a Jacobian q series. The logarithmic values of this series for various values of q have been tabulated in a previous paper by the author. When the circles are near one another a series for M is given in terms of q_1, where q_1 is the complement of q. In this paper the author treats Maxwell's second formula in a similar way. A table of the values of these series found, computed to six decimal figures by T. Tishima, is given.—S. E. **Hill**: The absorption of gases in vacuum tubes. This paper is an account of experiments carried out to determine whether the absorption of gases caused by passing a discharge for some time through vacuum tubes is the result of a chemical action or is a mere physical absorption. In order to eliminate all electrode complications, the electrodeless discharge was used throughout. The bulbs examined were of soda, lead, Bohemia and Jena glass. The absorptions were noted at different pressures and curves plotted. Continued passage of a discharge causes a "saturation" effect in all the glasses. After two months none of the bulbs had recovered any of their absorptive power. That chemical actions are present is shown by peculiar deposits on the necks of the bulbs, these being unfortunately too small for analysis. The conclusion arrived at is that the disappearance is not due to physical absorption, but to definite chemical action.

MANCHESTER.

Literary and Philosophical Society, October 15.—Mr. Francis Jones, vice-president, in the chair.—A. **Adamson**: An apparatus which can be used for the exact trisection of an angle.—D. M. S. **Watson**: The larger Coal Measure amphibia. The author described the skulls of *Loxomma Allmani* and *Anthracosaurus Russelli* (Pteroplax), now preserved in Newcastle-on-Tyne Museum. The skulls had been previously described by Embleton and Atthey, but the important structure of the palate had not been made out. This was described in detail, and compared with that of other Carboniferous amphibia. It was shown that a solid, bony palate, with an articular connection between the large pterygoids and the basisphenoid was characteristic of the group. The palatines and prevomers bear large teeth with a characteristic mode of replacement. The pre-maxillæ and maxillæ are confined to the margin of the palate, and bear smaller teeth. The large vacuities of the later Stegocephalia are absent. The skulls present remarkable resemblance to those of Seymouria and also of the Crossopterygian fishes. The relations of the quadrate were clearly determined, and seemed to indicate that the tetrapod skull was not autostylic in the ordinary sense.

PARIS.

Academy of Sciences, October 28.—M. Lippmann in the chair.—E. **Jungfleisch**: Inactive and racemic dilactylic acids. The crude acid arising from the interaction of sodium ethyl lactate and ethyl α-chloropropionate is neutralised with magnesium hydroxide. The inactive magnesium salt, being much less soluble in hot or cold water than the racemic form, separates first. The crystallographic properties of these salts, and of the corresponding acids are described.—Edouard

Heckel: Cultural bud mutation of *Solanum immite*. The mutation of the tubercles was obtained after only one year's culture.—A. **Schaumasse**: The provisional elements of the comet 1912*b*.—G. **Fayet**: Probable identity of the new comet 1912*b* with the Tuttle periodic comet. By its approach to Jupiter the Tuttle comet would appear to have undergone perturbation which would account for its advance by eighty-six days.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the first quarter of 1912. Observations were possible on sixty days, and the results are summarised in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—M. **Borrelly**: Observations of the Gale comet (1912*a*) made with the comet-finder at the Marseilles Observatory.—A. **Petot**: Certain conjugate systems.—Maurice **Gevrey**: Remarks on certain theorems of existence. A discussion of a class of functions previously considered by Holmgren.—Georges **Rémoundos**: The theorem of Picard and multiform functions.—A. **Guillet** and M. **Aubert**: An electrometric spark-gap consisting of two conducting spheres. Calculation of the charges, the potentials, the mutual action, and the disruption.—Ch. **Féry**: The principle of a new method of measuring the velocity of light. An application of the rotating mirror method, in which an electrically-controlled tuning-fork measures the angular velocity of the mirror.—A. **Boutaric** and C. **Leenhardt**: Cryoscopy in decahydrated sodium sulphate. Measurements of the molecular lowering of the freezing point with urea as the solute gave 32·05 as the value of the Van't Hoff constant; the figure 32·08 was obtained by the application of the usual formula to the latent heat of transformation of sodium sulphate.—Paul **Job** and Marcel **Boll**: The photochemical hydrolysis of very dilute solutions of chloroplatinic acids.—M. **Hanriot**: The tempering of metals. The author extends the meaning of a tempered metal to any metal which, after sufficient annealing, changes its physical properties, chemical changes being excluded.—Daniel **Berthelot** and Henri **Gaudechon**: The different modes of photochemical decomposition of glucose and galactose according to the wave-length of the radiations. A comparative study of the quantity and nature of the gases evolved from glucose and galactose in solution under the influence of ultra-violet light of three different wave-lengths.—H. **Baubigny**: Study of the double sulphites of mercury and the alkalis. The decomposition of solutions of the double sulphite of mercury and sodium differs from that of the corresponding salts of silver and copper in that no trace of dithionic acid is produced.—Maurice **Lanfry**: The action of hydrogen peroxide upon dithienyl-thiophene.—A. **Guyot** and A. **Kovache**: The action of formic acid upon the triarylcarbinols. All triarycarbinols, heated with a mixture of formic acid and a little dry sodium formate, are quantitatively reduced to the corresponding hydrocarbon, the amount of carbon dioxide produced being an exact measure of the reduction. The generality of the reaction is shown. André **Meyer**: Some new derivatives of phenylisoxazolone.—Marie **Korsakoff**: Researches on the methods for the estimation of saponines.—Leclerc du **Sablon**: The influence of light on the transpiration of green leaves and of leaves without chlorophyll.—M. **Ringelmann**: Calculation of the yield of small water channels in irrigation.—R. **Fosse**: Researches on urea. Urea is frequently present in the higher plants, although in very small proportions. It cannot be considered as proved that the urea is a physiological product of the plant cell.—Victor **Henri**, André **Helbronner**, and Max de **Recklinghausen**: A new, very powerful lamp for the production of ultra-violet light and its utilisation for the sterilisation of large quantities of water. The U-shaped lamp can be used on a 500-volt circuit, and requires 1150 watts, giving a candle-power of about 8000.—Em. **Bourquelot** and M. **Bridel**: Syntheses of glucosides of alcohols with the aid of emulsin. β-*iso*Propylglucoside and β-*iso*amylglucoside.—M. **Tiffeneau** and H. **Bosquet**: The rôle of caffeine in the diuretic action of coffee. Coffee loses the greater part of its effects on the renal secretions if the caffeine has been removed. Caffeine is the principal, if not the exclusive, agent of the diuretic action of coffee.—Robert **Odier**: Sensitised streptococcus and sarcoma.—B. **Sauton**: The mineral nutrition of the tubercle bacillus.—Max **Kollmann**: Some points on the anatomy of the male genital organs of Lemurs.

BOOKS RECEIVED.

Homo Sapiens. By Dr. V. G. Ruggeri. Pp. viii+198. (Vienna and Leipzig: A. Hartleben.) 5 marks.

Medizinisch-chemisches Laboratoriums-Hilfsbuch. By Dr. L. Pincussohn. Pp. xi+443. (Leipzig: F. C. W. Vogel.) 13·50 marks.

New South Wales Department of Mines. Geological Survey. Mineral Resources. No. 16: The Antimony Mining Industry and the Distribution of Antimony Ores in New South Wales. By J. E. Canve. Pp. 54+maps. (Sydney: W. A. Gullick.) 2*s*.

Government of India. Department of Revenue and Agriculture. Agricultural Statistics of India for the Years 1906–7 to 1910–11. Vol. i. Pp. iii+409. (Calcutta: Superintendent Government Printing, India.) 3*s*. 9*d*.

Memoirs of the American Museum of Natural History. New Series. Parts i., ii., iii. Pp. 100+plates. (New York: American Museum of Natural History.)

Summary Report of the Geological Survey Branch of the Department of Mines for the Calendar Year 1911. Pp. x+412+10. (Ottawa: C. H. Parmelee.)

Internal Secretion and the Ductless Glands. By Prof. S. Vincent. Pp. xx+464. (London: E. Arnold.) 12*s*. 6*d*. net.

Landolt-Börnstein. Physikalisch-chemische Tabellen. New edition. Edited by Drs. R. Börnstein and W. A. Roth. Pp. xvi+1313. (Berlin: J. Springer.) 56 marks.

Nautical Astronomy. By W. P. Symonds. Pp. 130. (London: J. D. Potter.) 6*s*.

The Fundamentals of Psychology. By B. Dumville. Pp. ix+382. (London: W. B. Clive.) 4*s*. 6*d*.

The Carbonisation of Coal. By Prof. V. B. Lewes. Pp. xiv+315. (London: J. Allen and Co.) 7*s*. 6*d*. net.

Leather Chemists' Pocket-book. Edited by Prof. H. R. Procter, assisted by Dr. E. Stiasny and H. Brumwell. Pp. xiv+223. (London: E. and F. N. Spon, Ltd.) 5*s*. net.

Outlines of Physical Chemistry. By Dr. G. Senter. Third edition. Pp. xix+413. (London: Methuen and Co., Ltd.) 5*s*.

The Elements of Geography. By R. D. Salisbury, H. H. Barrows, and W. S. Tower. Pp. viii+616+vii plates. (New York: H. Holt and Co.) 1.50 dollars.

Pflanzenwachstum und Kalkmangel im Boden. By Prof. A. Wieler. Pp. vii+235. (Berlin: Gebrüder Borntraeger.) 14 marks.

Terza relazione annuale del Direttore dell' Ufficio Idrografico. By G. Margrini. Pp. 71+plates+maps. (Venezia: C. Ferrari.)

Customs of the World. Parts i. and ii. (London: Hutchinson and Co.) 7*d*. each.

Papua, or British New Guinea. By J. H. P. Murray. Pp. 388. (London: T. Fisher Unwin.) 15*s*. net.

Evolution and the Need of Atonement. By S. A.

McDowall. Pp. xvi+155. (Cambridge University Press.) 3s. net.

Insect Workers. By W. J. Claxton. Pp. xii+62. (London: Cassell and Co., Ltd.) 1s. net.

Wild Life and the Camera. By A. R. Dugmore. Pp. xi+332. (London: W. Heinemann.) 6s. net.

The Charm of the Hills. By S. Gordon. Pp. xiv+248. (London: Cassell and Co., Ltd.) 10s. 6d. net.

A Geography of the British Empire. By Prof. A. J. Herbertson and R. L. Thompson. Pp. 256+3 maps. (Oxford: Clarendon Press.) 2s. 6d.

The Lost World. By A. Conan Doyle. Pp. 319. (London: Hodder and Stoughton.) 6s.

The Home Life of the Terns and Sea Swallows. By W. Bickerton. Pp. 88+32 plates. (London: Witherby and Co.) 6s. net.

Radium and Radio-activity. By A. T. Cameron. Pp. 185. (London: S.P.C.K.) 2s. 6d.

Astronomy. By Dr. F. W. Dyson. Pp. vi+118. (London: J. M. Dent and Sons, Ltd.) 1s. net.

On the Consciousness of the Universal and the Individual. By Dr. F. Aveling. Pp. x+255. (London: Macmillan and Co., Ltd.) 5s. net.

The Science of Illumination. By Dr. L. Bloch. Translated by Prof. W. C. Clinton. Pp. xiv+180. (London: J. Murray.) 6s. net.

A Handbook of Physics. By W. H. White. Pp. xv+667. (London: Methuen and Co., Ltd.)

The Prehistoric Period in South Africa. By J. P. Johnson. Second edition. Pp. 115+plates. (London: Longmans and Co.) 10s.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 7.

ROYAL SOCIETY, at 4.30.—Radiation and Absorption of Light in Gaseous Media, with Applications to the Intensity of Sky Radiation: L. V. King.—A Standard Measuring Machine: Dr. P. E. Shaw.—A Spectrophotometric Comparison of the Emissivity of Solid and Liquid Gold at High Temperatures with that of a Full Radiator: E. M. Stubbs and Dr. E. B. R. Prideaux.—Optical Properties of Substances at the Critical Point: C. Smith.—Absorption of Helium and other Gases under the Electric Discharge: Hon. R. J. Strutt.—(1) The Discharge between Concentric Cylinders in Gases at Low Pressures; (2) The Influence of the Nature of the Kathode on the Length of the Crookes Dark Space: F. W. Aston.—The Determination of the Absolute Unit of Resistance by Alternating Current Methods. A. Campbell.—Some Unclassified Mechanical Properties of Solids and Liquids: A. Mallock.—Trichromatic Theory of Colour Vision. The Measurement of Fatigue of the Retina: Sir W. de W. Abney, K.C.B.

FRIDAY, NOVEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Constitution of the Solar Corona. III.: J. W. Nicholson.—Telescope Finders: T. K. Mellor.—Suggested Application of Mr. Innes's Formula for Magnitude of Double Stars to Observations of Certain Variable Stars: M. E. J. Gheury.—(1) The Sun-spot Minimum: Sun-spots and Prominences, 1912, October 10; (2) Sun-spots and Magnetic Phenomena, 1848–1911. The Cause of the Annual Variation in Magnetic Disturbances: Rev. A. L. Cortie.—The Transit of Mercury in 1707: G. van Biesbroeck.—The Light-source of the Andromeda Nebula: J. H. Reynolds.—Note on the Oxygen Triplet of the Infra-red of the Solar Spectrum: Royal Observatory, Edinburgh.—(1) Spectrographic Observations of the Sun's Rotation at Cambridge Observatory; (2) A Method of Measuring Spectrograms with the Help of a Cylindrical Lens: J. B. Hubrecht.—The Sidereal System: Revision of 1912 (*continued*) Maxwell Hall.—*Probable Paper:* Note on the Magnitude of Nova Geminorum: H. Jameson.

PHYSICAL SOCIETY, at 8.—On a Method of Measuring the Thomson Effect: H. R. Nettleton.—An Improved Joule Radiometer and its Applications: F. W. Jordan.—Note on the Attainment of a Steady State when Heat Diffuses along a Moving Cylinder Miss A. Somers.—The Thermomagnetic Study of Steel: S. W. J. Smith.

MALACOLOGICAL SOCIETY, at 8.—Tivella and Grateloupia: A J. Jukes-Browne.—Some Remarkable Shell Monstrosities: G C. Robson.—New Mollusca from the Marine Tertiary Deposits of the North Pacific Coast of America: Ralph Arnold and Harold Hannibal.—Descriptions of new species of Limicolaria and Krapfiella from East Central Africa: H. B. Preston.

TUESDAY, NOVEMBER 12.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of the New Dock at Methil: B. H. Blyth.—Alterations and Improvements of the Port Talbot Docks and Railway during the Last Decade: W. Cleaver.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Some unrecorded Customs of the Mekeo People of British New Guinea: R. W. Williamson.

ZOOLOGICAL SOCIETY, at 8.30.—Some Falkland Island Spiders: H. R. Hogg.—Some Points in the Anatomy of the Mouth-parts of the Mallophaga: Bruce F. Cummings.—Contributions to a Study of the Dragonfly Fauna of Borneo. I. The Corduliinæ: the Genus Amphicnemis: F. F. Laidlaw.—Some Parasites of the Scoter Duck (*Oedemia nigra*) and their Relation to the Pearl-inducing Trematode in the Edible Mussel (*Mytilus edulis*): Dr. H. Lyster Jameson and Dr. W. Nicoll.—Descriptions of Three New Fishes Discovered in the Gold Coast by Dr. H. G. F. Spurrell: G. A. Boulenger.

MINERALOGICAL SOCIETY, at 5.30.—Ilmenite from the Lengenbach Quarry, Binnenthal: Prof. W. J. Lewis.—An Account of the Minerals found in the Virtuous Lady Mine, near Tavistock: A. Russell.—Some Graphical Methods in Crystallography and Crystal Optics: A. Hutchinson.—Labradorite from Co. Down: A. Hutchinson and W. Campbell Smith.—Apparatus for Preparing Thin-sections of Rocks: Dr. G. F. Herber Smith.—Calcite Crystals from a Water Tank: R. F. Gwinnell.

THURSDAY, NOVEMBER 14.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Development of a Parasite of Earthworms: J. W Cropper.—Further Contribution to the Study of the Inheritance of Hoariness in Stocks (Matthiola): Edith R. Saunders. The Influence of Temperature on the Absorption of Water by Seeds of *Hordeum vulgare* in Relation to the Temperature Co-efficient of Chemical Change: Prof. A. J. Brown.—Note on *Merlia normani* and the "Monticuliporas": R. Kirkpatrick.—The Chemical Action of *Bacillus cloacae* (Jordan) on Citric and Malic Acids in the Presence and Absence of Oxygen: James Thompson.—The Origin and Destiny of Cholesterol in the Animal Organism. X. The Excretion of Cholesterol by Man, when Fed on Various Diets: G. W. Ellis and J. A. Gardner.—The Comparative Anatomy and Affinities of the Araucarineae: Prof. R. Boyd Thomson. *And other Papers.*

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Address by the President (W. Duddell.)—Presentation of Premiums.

CONCRETE INSTITUTE, at 7.30.—Presidential Address: E P. Wells.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—Presidential Address on Recent Advances in the Theory of Surfaces: H. F. Baker.—Some Properties of Cubic Surfaces: A. B. Grieve.—The Determination of the Summability of a Function by means of its Fourier Constants: W. H. Young.—Groups of Linear Substitutions of Finite Order which Possess Quadratic Invariants: W. Burnside.—The Irreducibility of Legendre's Polynomials: J. B. Holt.—The Representation of a Summable Function by means of a Series of Finite Polynomials: E. W. Hobson.—Theory of Functions of Real Vectors: E. Cunningham.

FRIDAY, NOVEMBER 15.

ROYAL GEOGRAPHICAL SOCIETY, at 8.45.—The Norwegian South Polar Expedition: Capt. Roald Amundsen.

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THURSDAY, NOVEMBER 14, 1912.

ELECTRONS AND THE ELECTROMAGNETIC FIELD.

Electromagnetic Radiation and the Mechanical Reactions arising from it. Being an Adams Prize Essay in the University of Cambridge. By Dr. G. A. Schott. Pp. xxii + 330. (Cambridge: University Press, 1912.) Price 18*s*. net.

PROF. SCHOTT'S original essay is, in this book, supplemented by a series of valuable appendices, which amply justify the delay in its publication. The work is deductive in plan; its foundations are the electromagnetic equations of Maxwell and Hertz, together with the Larmor-Lorentz expression for the mechanical force on a moving charge. The "retarded potentials" of the electromagnetic field are transformed so as to yield Schott's solutions, in the form of "modified Fourier integrals," and most of the calculations are performed from these as starting point. They lead simply, and with considerable mathematical rigour, to many results obtained by other writers; in particular, the "point laws" of Liénard and Wiechert are deduced, and are used to illustrate the general features of the electromagnetic field in a number of special cases. The exact calculations, however, are more readily executed with Schott's expressions, and various simple cases of motion of electrons are thus dealt with, as, *e.g.*, uniform or uniformly accelerated rectilinear motion. Periodic motions, such as uniform circular motion of a single electron, or of a ring of electrons, are also discussed. More complex cases, like pseudo-periodic or aperiodic motions, cannot be solved completely, but the distant field is approximated to. Specially interesting are the problems relating to the pulse theory of the X-rays, and the precessional motion of a ring of electrons, as applied to Ritz's theory of the Zeeman effect.

The velocities of the electrons are not restricted to be less than the velocity of light, chiefly because the mathematical expressions require no such condition (though the work is far simpler in the restricted case). It is pointed out that no experimental evidence, either way, has been brought to settle the question of the possibility of velocities exceeding that of light; if the Lorentz mass-formula were universally true, indeed, the question would be decided in the negative, but this formula has been verified (by Bucherer) only for velocities considerably less than that of light. Moreover, the theory of relativity, which is based on this formula and has proved useful in explaining aberration phenomena and the behaviour of moving optical systems, neglects the loss of energy by radiation from accelerated charges; this, however, becomes very important for velocities approaching that of light.

In the appendices several theorems are proved which lead up to an interesting discussion of the possible mechanical explanations of the electron. It is shown that the Lorentz deformable electron is more easily explained mechanically than the electrons of Abraham and others, as it only requires an invariable hydrostatic pressure of the æther over its surface to enable it to subsist. This pressure is estimated (p. 269) as 10^{25} atmospheres. Moreover, the mass-formula for such an electron is practically the only one which can be applied in the mathematical theory of the mechanical forces and the radiation.

For the mathematician the book abounds in problems and suggestions of interest and importance; especially does it clearly display the need for the cooperation of the pure analyst in the study of the summation and convergence of the difficult series and integrals which occur in its investigations. The physicist will, perhaps, find it rather tedious to unearth the physical conclusions (which are pointed out from time to time in the course of the work) from the mass of complicated mathematics in which these remarks are involved. The great value of the book would have been increased if the physical bearing of the results had been summarised in an extra chapter; this is done to a slight extent in the preface. A greater number of numerical calculations would also have been advantageous in giving a clearer grasp of the results, but the great labour required for such an undertaking sufficiently explains the omission.

THE LAND AND ITS LORE.

(1) *Common Land and Inclosure.* By Prof. E. C. K. Gonner. Pp. xxx + 461 + 5 maps. (London: Macmillan and Co., Ltd., 1912.) Price 12*s*. net.

(2) *Byways in British Archaeology.* By Walter Johnson. Pp. xii + 529. (Cambridge: University Press, 1912.) Price 10*s*. 6*d*. net.

(1) SCIENTIFIC studies of the history of land-holding have a peculiar importance at the present moment, when legislative innovations in ownership are so widely mooted on *a priori* grounds. By supplying valid inductions from the past, science here, as in other spheres, provides the statesman with a solid foundation for political principles, and a sure test for fallacious schemes.

The entire history of English agriculture, so far as it is connected with national progress and advance in civilisation, is bound up with "common" and inclosure, and the passage from the former to the latter. The land question, it is not too much to say, cannot be begun to be understood until this relation has been worked out.

"Common" in early times was "in entire contrast to the ideas associated with it in the present day. . . . Its existence now is taken as denoting the claims, somewhat vague and precarious, of the public as against those holding the land and engaged in its cultivation. But this finds no sanction in a time when . . . common was a result of a claim to land, and formed a necessary condition of its proper management. . . . The early rights of common were anything . . . rather than a general claim on the part of the public. . . . The common right was an essential part of agriculture, and it was only as, owing to changes in circumstances, this became less apparent, that casual profits and gains and the so-called rights of the poor, these latter being in many instances a trespass and not a right, came to be important."

Thus Prof. Gonner defines his subject. The history of the method of common and of the gradual progress of inclosure occupies two-thirds of the volume. The rest is devoted to the effects of the evolutionary change. Inclosure is part of "a wider economic movement." Its "beneficial effect on farming is undoubted . . . particularly in the increased utilisation of what is, after all, the distinctive agricultural wealth of England, rich grazing and dairy lands." Of particular importance is its connection with "the change whereby agriculture, from being a means of subsistence to particular families, had become a source of wealth to the nation." It is particularly interesting to the sociologist to note that rural population "did not vary with inclosure, and that this movement was not, at any rate, the main cause of the increase in poor relief expenditure."

Prof. Gonner has written an invaluable study, which is final, and should become a classic. No sociologist and no statesman can afford to ignore it.

(2) The author of "Folk Memory" devotes 400 pages to answering the question: In what ways may the church-fabric be regarded as the social centre of early English life? There is abundance of original observation, and in controverted matters, such as round towers, the author's judgment is eminently reasonable. For he treats these radiating paths of folklore—they are this rather than byways—from a wide sociological outlook. In "The Folklore of the Cardinal Points," and "The Labour'd Ox," he treats new ground. "The Cult of the Horse" is an interesting compilation of palæontological data and early English horselore. The "White Horse," and what amounts still to a tabu against eating horseflesh, receive illumination. Mr. Johnson believes that folk-memory is on the wane, since "the printed book and the daily newspaper . . . remove the need for its lawful exercise." It would be more scientific, perhaps, to regard the ultra-popular reactions to these modern influences as being themselves a new stage of folk-thinking and folk-memory.

A. E. CRAWLEY.

ENGINEERING HANDBOOKS.

(1) *Reference Book for Statical Calculations (Rapid Statics), Force-diagrams for Frameworks, Tables, Instructions for Statical Calculations, &c., for all Classes of Building and Engineering.* By Francis Ruff. Pp. 136; illustrated. Vol. i. (London: Constable and Co., Ltd., 1912.) Price 4*s.* net.

(2) *Les Nomogrammes de l'Ingénieur.* By Ricardo Seco de la Garza. Avec une Préface de Maurice d'Ocagne. Pp. xii + 195 + 85 plates. (Paris: Gauthier-Villars, 1912.) Price 12 francs.

(3) *Laboratory Instruction Sheets in Elementary Applied Mechanics.* By Prof. A. Morley and W. Inchley. Pp. v + 50. (London: Longmans, Green and Co., 1912.) Price 1*s.* 3*d.* net.

(4) *A Handbook on the Gas Engine.* Comprising a Practical Treatise on Internal Combustion Engines. By Herman Halder. Translated from the German and Edited by W. M. Huskisson. Pp. xii + 317. (London: Crosby Lockwood and Son, 1911.) Price 18*s.* net.

(5) *Concrete Costs.* Tables and Recommendations for Estimating the Time and Cost of Labour Operations in Concrete Constructions and for Introducing Economical Methods of Management. By Dr. Frederick W. Taylor and Stanford E. Thompson. First edition. Pp. xxii + 709. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.) Price 21*s.* net.

(1) THE usual graphical methods for determining the stresses in framed structures form the subject of this little book. With the exceptions of the wind pressure on roof trusses, the load on a framework column, and pressure upon retaining walls, the structures are subjected to symmetrical loads concentrated at the joints. Each form of roof, bridge truss, girder, or cantilever occupies a separate page, together with its reciprocal figure, the construction of the force polygons being described on the opposite sheet. There are some thirty examples of the usual forms of truss, covering the ordinary cases that occur in engineering practice. The method adopted of forming the reciprocal figures loses much by the notation employed, and is far less satisfactory

than Bow's notation, in which the spaces between the members of a structure are designated by a letter or numeral. The concluding third of the book contains a short dissertation on reinforced concrete (in which the ratio of the moduli of elasticity of steel to concrete is taken at the low value of 10), and this is followed by tables usually found in engineers' handbooks on the geometrical properties of structural shapes, such as moments of inertia. There are many blemishes due to imperfect translation, and we find such expressions as "10-fold security" for "factor of safety of ten." The translation does not extend to weights and measures, which are in the metric system.

(2) The preface to this volume is, for the most part, a reprint of remarks made by M. Maurice d'Ocagne, Ingénieur en chef des Ponts et Chaussées, at the Fourth International Congress of Mathematicians, in Rome, 1908. In this paper he defines the word "nomogramme," which is probably new to most English mathematicians, the nearest English equivalent being an abacus, known as an instrument for performing calculations by balls sliding on wires, which are still employed in Russia, China, and Japan. M. d'Ocagne has brought forward this system of graphical calculation by published researches extending over twenty-five years, and the author of this work employs the method for solving problems in military engineering, though many of the examples are of wider application, and are of extended use in the solution of equations of three or four (or more) variables. The interest in the work would therefore lie chiefly in the method as such, the particular applications of the method to the solution of equations used by the military engineer being of secondary importance, though, as a handbook for rapid calculation within the limits of the chosen field of utility, it would certainly serve a useful purpose to many. The reader will doubtless find himself constructing nomogrammes to suit particular problems of his own, and thus the work before us is extremely suggestive, and a fruitful stimulus to the use of a graphical method of varied application.

There are eighty-five nomogrammes in the work, each on a separate sheet and consisting for the most part of straight lines upon which divisions are marked. A loose celluloid sheet marked off in rectangular coordinates is provided for laying upon the nomogramme, and upon placing it in such a position that the known values of the variables in the equation are cut by the lines, the value of the unknown variable may be ascertained by intersection upon the scale provided for that variable. Thus, for example, the solution of plane triangles may be taken as being a problem of general application. Given the two sides and included angle, the opposite side (a) may be found directly by the application of the rectangular coordinates to the nomogramme; in other words, the equation $a^2 = b^2 + c^2 - 2ab \cos A$ may be solved for all values of b, c and A. Besides the usual problems in mensuration, the safe loads on columns for given values of the ratio of length to least radius of gyration for various materials, the bending of beams, stresses in roof trusses and bridges and numerous other problems may be solved without calculation. The printing of the scales on the nomogrammes leaves much to be desired, but the work as a whole is a most interesting contribution to graphical methods of solution.

(3) This little book is made up of twenty-five single perforated sheets bearing upon each a concise description of a simple laboratory experiment in applied mechanics with an illustration of the apparatus. The experiments are of the usual kind for the elementary mechanical laboratory and comprise statics, efficiency of lifting machines and friction, forces in braced structures, moduli of elasticity, spring vibrations, pendulum, and others. Prof. Morley states that they are selected from instruction sheets used in his laboratory, and may be usefully employed in conjunction with his text-books on elementary applied mechanics. However opinions may differ concerning the expediency of giving a student cut-and-dried directions concerning his laboratory work and leaving little to his own judgment and talent, those who favour this plan of instruction will find all that they desire in these well-arranged experiments. It saves much time and needless explanation on the part of the demonstrator to have the experiments written out, and as these are selected by experienced teachers they should prove useful in the elementary laboratory.

(4) This work contains a mass of constructional detail on the gas engine which should find favour with engineers and draughtsmen engaged in the design of such motors. It represents the results of much practical experience, and on the part of both the author and translator it shows a very careful scrutiny of the best engineering practice. The thermodynamics of the subject is somewhat neglected, but this omission is counterbalanced by the exhaustive treatment of the forces developed by the engine when running. The effect of the inertia of the reciprocating parts, turning moment diagrams for calculating fly-wheel masses, and balancing, are discussed with the view of assisting the draughtsman in his design, and the effects of various combinations of cylinders receive more attention than usual in works of this kind. Minute details are set forth with painstaking care, and

there is no part of the anatomy of the engine which has not a place in the work. Metric measures have been converted by the translator, but the tabulated dimensions of Continental engines have been retained in millimetres in parallel columns.

(5) The cost of mixing and laying concrete is essentially governed by local circumstances, and it would be unsafe to generalise from isolated results, however carefully they may have been collected. The authors have been at great pains to collect information based upon work done in the United States, and no doubt with due allowance for the difference in the cost of labour and materials and the varying rate of output of work, much of their conclusions would be applicable to other conditions and places. But the work is not wholly confined to questions of cost, for it contains much valuable, if incidental, information concerning the making of concrete in bulk, form of moulds, reinforcement for ferro-concrete and other matters pertaining to construction in this material. It is to be regretted that so much prominence was given to costs, though the title of the work very clearly points to this as the dominant feature. Nevertheless, with due allowances, as a reference book there is much in it for the architect and engineer, and it is eminently satisfying to know that the figures were obtained by close application and systematic study of construction work for many years.

OUR BOOKSHELF.

Manual Training Woodwork Exercises Treated Mathematically. A Scheme for Linking up Practical Mathematics with Woodwork; including a Complete Course of Mensuration. By F. E. Drury. Pp. xi+215. (London: G. Bell and Sons, Ltd., 1912.) Price 2*s*. 6*d*.

As is indicated by the title, the author's object in preparing this volume has been to show how practical mathematics may be linked up with woodwork in the form of mensuration, &c. The book is intended for use in preparatory day trade schools, some secondary schools, and in evening continuation and technical courses of an elementary character. It is stated that the work of calculation is intended to be an application of the principles received in lecture and experimental classes, but it will be seen that these may, in a large measure, be imparted by the woodwork teacher if he has a generous allowance of time. With this end in view, the book contains a very good systematic course in mensuration, elementary algebra, and the construction and properties of simple graphs; the application of these principles to the course of woodwork exercises provided is clear and good, and the book should be very useful to manual instructors who are expected to train boys both in practical mathematics and woodwork.

As to the desirability of adopting this course there may be difference of opinion, especially with reference to evening schools, where the time permitted for actual work in the wood shop is very limited. Any reason which may be advanced for bracketing together woodwork and mathematics may equally well be applied to other branches of practice, with a consequent multiplication of the number of classes in practical mathematics carried on in the same building, each no doubt selecting those portions which appear to suit the particular trade involved. It is fairly obvious that such a plan—already adopted in some institutions—cannot fail ultimately to lower mathematical standards. The author has been successful in carrying out his views in the book, and, if it be regarded as a further means of interesting students in the woodwork shop in their work in classes under the supervision of mathematical teachers, it can be highly commended. The woodwork examples are good, and the book is well and clearly illustrated.

Compendio Elemental de Zoología. By Ángel Gallardo. Pp. 360. (Buenos Aires: Ángel Estrada y Cia, 1912.)

PROF. ÁNGEL GALLARDO has prepared a useful elementary text-book of zoology, specially adapted for the Argentine Republic. After an introduction contrasting organisms and inorganic things, comparing plants and animals, describing cells and tissues, and the early stages of development, discussing the factors of evolution and other generalities, the author passes to a rapid survey of the animal kingdom. The book is very clearly and tersely written, with numerous illustrations, for the most part admirable. In the classification adopted, "Tipo vii., Lofostomas," includes the three classes—Rotifers, Bryozoa, and Brachiopods—characterised by the tentacular apparatus at the mouth. Still more doubtful is "Tipo viii., Gusanos," which includes Annelids and Plathelminthes, characterised by having trochosphere larvæ.

Twelve Moons. By Frances A. Bardswell. Pp. 90. (London: Elkin Mathews, 1912.) Price 2*s*. 6*d*. net.

IN twelve short sections devoted to the respective months of the year, the author expresses pretty sentiments upon the changing beauties of the countryside. She loves the poetry of nature; and her words will awaken sympathetic response in readers who are content to contemplate the surface of things. The old proverb "February Fill-dyke" leads her to say: "To brim the ponds and flood the waterways is the mission of the month." As a matter of fact, the average rainfall of February in England as a whole is less than that of either January, August, October, November or December, though there are local differences. Possibly the explanation of the proverb is not that "deluges of rain" actually fall in February, but that the watercourses begin to fill up during that month as the result of the rise of the water-table due to the rainfall of preceding months.

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.*]

Radium and Earth History.

It would appear that radium has landed geologists and biologists in a difficulty greater than that from which it was hoped it would deliver them. There is radium in the earth, and radium in disintegrating gives out heat. Therefore a once molten globe will cool down more slowly than if it contained no such independent source of heat. Lord Kelvin's calculations were made on the supposition that there was no source of heat except what the earth possessed as a molten globe. Hence we are at liberty to extend the time that has elapsed since the earth became the possible theatre of geological change to 500,000,000, 1,000,000,000, or even more, years ago. Radium has given us a blank cheque on the bank of time.

So far so good. But when the actual calculations were made as to how much the radium known to exist in the outer shell of the earth would effect its cooling, this was found to be too great. It would, in fact, *raise* the temperature of the earth the fraction of a degree annually.

Two suggestions in the way of explaining the difficulty have been made by Prof. Joly in his "Radioactivity and Geology." We do not think that either will bear the test of careful examination.

It is only the outer shell of the earth that can be examined for radium, and though there appears to be no diminution with depth, there may be less, or none, in the lower parts. If, then, we have to spread the heating effects of the radium of the outer shell over the whole earth, it will obviously be insufficient to raise its temperature. The only possible result of its disintegration will be a retardation of its cooling to an indefinite extent, which is what is wanted. This is the first suggestion.

The second, admitting that the proportion of radium in the interior may be the same as at the surface, avails itself of the fact that vast masses of the central earth may be thermally isolated for immense periods of time. The rise in temperature of such parts—due to their radium—need not, then, affect the rocky crust. In the course of prolonged ages, however, such internal reservoirs of heat might, so to speak, overflow. Great rushes of heat might reduce the outer shell to a molten state, and inaugurate a new geological era. To quote Prof. Joly:—

"With an interest almost amounting to anxiety, geologists will watch the development of researches which may result in timing the strata and the phases of evolutionary advance; and may even—going still further back—give us reason to see in the discrepancy between denudation and radio-active methods, glimpses of past æons, beyond that day of regeneration which at once ushered in our era of life, and, for all that went before, was 'a sleep and a forgetting.'"

But let us look at these interesting suggestions a little more closely. If the radium contents of the outer shell were spent in heating the whole earth—or any considerable portion of it beyond the shell containing it—then we might suppose it just sufficient to retard its cooling indefinitely. But as the temperature of the earth increases with depth, we cannot suppose that any of the radium-generated heat of the outer shell passes downwards. It must *all* be spent in heating its *own mass*. Therefore, according to calculation, this outer shell should be rising in temperature. There seems to be no escape from this conclusion. And this applies also—and even more forcibly—to the second explanation. For with an interior rising in temperature it is still more difficult to imagine any of the radium-generated heat of the outer shell passing downwards. The radium heat of the crust must all be spent on itself.

Even this does not express the full extent of the difficulty. The theory of the radio-active elements is that they have their periods in which they lose half their substance. The period of radium is 1760 years, and that of uranium 5,000,000,000 years. Now, since we know of no source whereby the supply of uranium in the earth is replenished, we must suppose that there was twice as much uranium 5000 million years ago as there is to-day. And whatever length of time we go back we must suppose there was more uranium, and hence a greater heating effect, than there is to-day. A molten globe could not *begin* to cool until the radium contents of its outer shell were *less* than that of the earth to-day.

The moon presents another difficulty. Our satellite is generally held to be a bit of the earth thrown off some fifty-six million years ago. It was then molten, and the drag of the tides produced in its molten mass by the earth gradually reduced its rate of rotation. Now it only turns once on its axis in the course of a revolution round the earth. The moon's radium has not prevented it reaching a stage of cooling far beyond that of the earth. And yet the moon may be supposed to have had the full proportion of radium known to exist in the outer shell of the earth. Yet it has cooled down from a molten state in fifty-six million years in spite of its radium! And it would appear that the earth has done the same, although it has not reached the same stage. For if the moon was molten when it began its separate existence, so must the earth—which gave it birth—have been.

And it would appear that there must be *more* radium in the sun than in the earth. For helium, the product of the disintegration of radium, was discovered spectroscopically in the sun years before it was known on earth. It must surely, therefore, exist there in much larger quantities. Hence the sun should be getting hotter at a greater rate than the earth.

The difficulties introduced by radium into earth history are greater than that which it was hoped it would remove.

G. W. Bulman.

The Moon and Poisonous Fish.

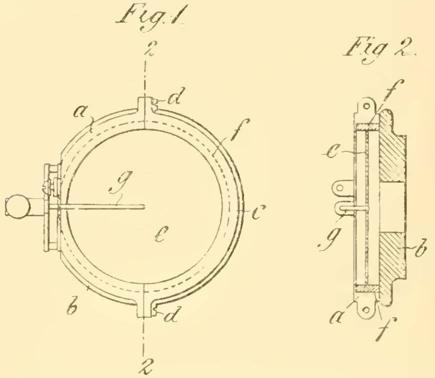
May I ask for a little space in your columns to inquire if any of your readers can give any information as to the origin of a belief, very widespread in South Africa, that fish exposed to the influence of moonlight becomes poisonous? I have not yet attempted any experiments to test the truth of the statement, nor have I been able to obtain actual evidence of illness or death following the eating of such fish. The belief is very firmly rooted here among all classes of persons, but no one seems able to say how or when it originated, or on what grounds it is based. One very trustworthy witness told me that he had accidentally left some fresh fish out in the moonlight one night, and that it was quite bad in the morning; he admitted, however, that the closeness of the atmosphere might have occasioned the effect, and, of course, he did not divide the sample so as to keep part of it unexposed. I intend to test the statement experimentally when opportunity offers; meanwhile possibly some of your readers can say whether the belief in this ill-effect of moonlight is found in other localities.

E. G. Bryant.

Grey Institute, Port Elizabeth, Cape Colony,
October 7.

Gramophone Experiments.

FOR some time I have been experimenting with the gramophone sound-box, and I came to the conclusion that with a diaphragm nipped firmly between two rubber rings there was a tendency for a vibration from the stylus bar to be cannoned back from the edge so held, and that one did not get a true ring. I made a sound-box as shown below (Figs. 1 and 2) in



FIGS. 1 and 2.—a is half a split ring connected to the sound box b; c is the other half of the split ring connected to a by screws $d\,d$; the diaphragm e is held in position by an elastic ring f, which is secured to sound box by means of the two halves a and c; g is the stylus bar. The sound box is protected by patent.

which the diaphragm is only held on its edge, and by cutting the front of the box in half it enabled me to mount the diaphragm free from distortion. With this box there is a very marked difference.

In a band record one can differentiate each instrument more readily.

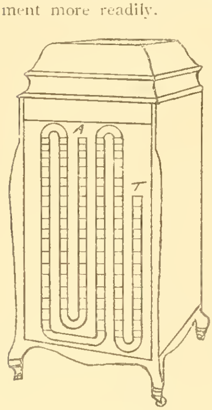


FIG. 3.—A connected with tapered arm: T with horn.

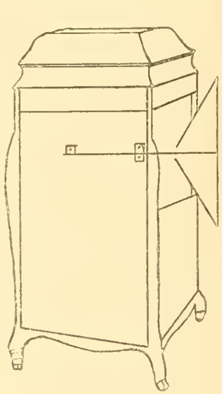


FIG. 4.—Showing position of conical reflector.

Working on Prof. McKendrick's experiments, as described in NATURE of April 20, 1911, I found that with an enclosed horn machine, as shown in Figs. 3 and 4, by passing the sound waves through about 17 ft. of 2-in. flexible metallic voice tube (the tubes all being inside the cabinet out of sight), all the noises which he eliminates by the use of peas are done away with, and the sound much increased by not using peas. In addition to this, to augment the sound I place a 2 ft. by 8 in. deep conical reflector with the apex of the cone cut off, leaving a 4-in. opening pointing to horn, as shown in Fig. 4. The result is that a musical effect is produced free from overtones and harsh sounds.

ERNEST DE LA RUE.

WITH reference to the above interesting communication by Mr. Ernest de la Rue, I have to say that the method he has adopted for fixing the diaphragm of the sound-box is a marked improvement. Mr. de la Rue has kindly sent me a specimen of the sound-box, and it has given me great satisfaction, both as to quality and volume of tone. I have not had the opportunity of hearing the arrangement he has devised for removing friction noises, but no doubt it will be satisfactory. I am quite pleased with my own method, which gives excellent results, and it is adapted to the older form of gramophone which I use. The tones are sufficiently loud for a room of ordinary dimensions, and the quality, with Mr. de la Rue's sound-box, is excellent. A witty friend of mine has called my plan the pipe of peace (peas)!

J. G. MCKENDRICK.

Reported Occurrence of the Dartford Warbler at the Tuskar Light Station.

I HAVE recently returned after nine weeks' residence at the Tuskar Light Station, off the south-east coast of county Wexford, where I have been prosecuting the study of bird-migration. I obtained several interesting records, including those of some rare species. To these may be added a highly interesting and at the same time important record of the occurrence of a Dartford warbler. Owing to the sedentary habits of this species its appearance at the Tuskar Rock was quite unexpected, and heretofore the bird was unknown in Ireland.

This warbler was obtained on October 27, as I am informed by the principal lightkeeper, to whom I owe my cordial thanks for the kind aid he has so often and cheerfully given me in connection with my work on bird-migration.

C. J. PATTEN.

The University, Sheffield, November 10.

THE CRYSTAL SPACE-LATTICE REVEALED BY RONTGEN RAYS.

DURING a visit to Munich at the beginning of August last the writer was deeply interested in some extraordinary photographs which were shown to him by Prof. von Groth, the *doyen* of the crystallographic world, and professor of mineralogy at the university of that city. They had been obtained by Dr. M. Laue, assisted in the experiments by Herren W. Friedrich and P. Knipping, in the laboratory of Prof. A. Sommerfeld in Munich, by passing a narrow cylindrical beam of Röntgen rays through a crystal of zinc blende, the cubic form of naturally occurring sulphide of zinc, and receiving the transmitted rays upon a photographic plate. They consisted of black spots arranged in a geometrical pattern, in which a square predominated, exactly in accordance with the holohedral cubic symmetry of the space-lattice attributed by crystallographers to zinc blende.

Prof. von Groth expressed the opinion, in agreement with Herr Laue, that owing to the exceedingly short wave length of the Röntgen rays (assuming them to be of electromagnetic wave character), they had been able to penetrate the crystal structure and to form an interference (diffraction) photograph of the Bravais space-

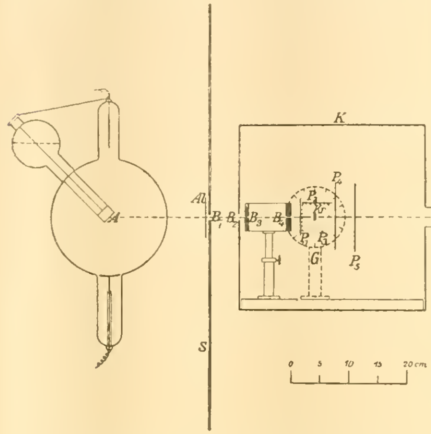


FIG. 1.—Diagrammatic representation of Dr. Laue's apparatus.

lattice. This latter is the structural foundation of the more complicated regular point-system according to which the crystal is homogeneously built up, and the points of which (the point-system) represent the chemical elementary atoms. The space-lattice, in fact, was conceived to play the same function with the short-wave Röntgen rays that the diffraction grating does to the longer electromagnetic waves of light.

The details of this work were laid before the Bavarian Academy of Sciences at Munich in two memoirs, on June 8 and July 6 last, and the two memoirs are now duly published in the *Sitzungsberichte* of the Academy.[1] Besides a diagram of the apparatus, which is reproduced in Fig. 1, they are illustrated by reproductions of a dozen of these photographs, one of which is also reproduced in Fig. 2. There can be no doubt that they are of supreme interest, and that they do in reality afford a visual proof of the modern theory of crystal structure built up by the combined labours of Bravais, Sohncke, Schönflies, von Fedorow, and Barlow. Moreover, they emphasise in a remarkable manner the importance of the space-lattice, so strongly insisted on from theoretical considerations by Bravais, Lord Kelvin, and von Groth, and from experimental considerations by Miers and the writer. They further confirm the structure assigned to this binary compound zinc sulphide, ZnS, by Pope and Barlow. Incidentally they may form a crucial test of the accuracy of the two rival theories now being discussed as to the nature of X-rays, the corpuscular and the wave theory.

[1] *Sitzungsber. der Kön. Bayerischen Akad. der Wiss., Math. Phys. Kl.*, 1912, 303 and 363.

Out of an excellent crystal of zinc blende a plate was cut a centimetre square and half a millimetre thick, parallel to a cube face (100), that is, perpendicular to one of the principal cubic crystallographic axes of the crystal (a tetragonal axis of symmetry). The plate was supported in the usual manner on the crystal holder of a goniometer, and precisely adjusted so that a beam of Röntgen rays one millimetre in diameter impinged perpendicularly upon it, after passing first through a series of screens to eliminate secondary radiations from the glass walls of the Röntgen tube. The last screen, which gave the final form to the bundle of rays, was a plate of lead a centimetre thick, pierced by a cylindrical hole 0·75 millimetre in diameter, and fitted with a delicate means of adjustment so that the axis of the boring could be brought exactly perpendicular to the crystal plate. The beam of pure Röntgen rays of circular section thus passing through the crystal normally was received, also normally, on a Schleussner-Röntgen photographic plate, which was subsequently developed with rodinal. The time of exposure in different experiments varied from one to twenty hours, the whole apparatus being excluded from all ordinary light by a covering box.

The positive print, reproduced in Fig. 2, from the negative thus obtained shows a central circular black spot, about half a centimetre in diameter, surrounded symmetrically by sixteen smaller black spots of about the same intensity, but of elliptical shape (about two millimetres long), arranged in a diagonally

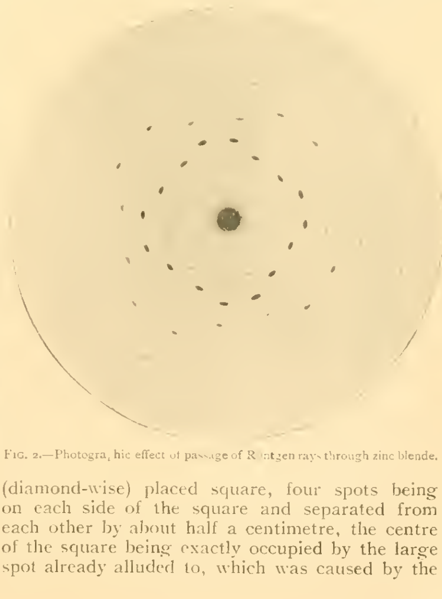


FIG. 2.—Photographic effect of passage of Röntgen rays through zinc blende.

(diamond-wise) placed square, four spots being on each side of the square and separated from each other by about half a centimetre, the centre of the square being exactly occupied by the large spot already alluded to, which was caused by the direct rays. Outside the square of spots were others of a fainter character, also arranged with similar cubic symmetry, and there was also a faint square of spots inside the intense square, nearer to the latter than to the large central spot.

The tetragonal nature of the axis of symmetry along which the Röntgen rays were travelling through the crystal is most strikingly apparent in the photograph. One recognises at once also the presence of two perpendicular planes of symmetry in the arrangement of the spots. In fact, *the figure corresponds to the holohedral or full symmetry (class 32) of the cubic system*, in spite of the fact that zinc blende belongs to the hexakis-tetrahedral class 31 (one of the so-called hemihedral classes) of cubic symmetry. Now this interesting fact affords the most beautiful and perfect proof that it is the space-lattice (Raumgitter) of the crystal structure which is affording the figure, and that no other property than this space-lattice is concerned. For space-lattices alone always possess holohedral symmetry, and they determine the crystal system and angles and obedience with the law of rational indices. Interpenetrations, translations, and coincidence-movements of space-lattices, which afford those of the sixty-five Sohncke regular point-systems which account for the simpler cases of hemihedrism (types of crystals of lower than holohedral symmetry), are here obviously not concerned; still more emphatically, if possible, is this true of the 165 yet more complicated point-systems involving mirror-image symmetry made known to us by von Fedorow and Barlow.

In other words, it is not the stereographic arrangement of the elementary atoms which is revealed by the photographs, but the underlying space-lattice, which is arrived at by taking the atoms of the same chemical element which are similarly (sameways, identically) situated throughout the whole structure. This may either mean (in very simple cases) taking a similarly situated atom in each chemical molecule, or (more generally) one such atom in a group of molecules. In the case of zinc blende, if Pope and Barlow's conception of the structure be correct,[2] only one zinc or sulphur atom in every group of sixteen molecules is thus sameways orientated, thirty-two atoms (sixteen of zinc and sixteen of sulphur) going to form the complete, double, regular point-system (each atom being considered as a point, and the sixteen atoms of each element forming a simple regular point-system).

In order to be quite clear, the definition of crystal structure may be quoted which was given by Prof. von Groth at the 1904 meeting of the British Association. Mr. Barlow has since amplified the statement so as to include the more complicated cases, but as these are not concerned in the case of zinc blende the definition is fully adequate for our purpose.

A crystal—considered as indefinitely extended—consists of n interpenetrating regular point-systems, each of which is formed from similar atoms; each of these point-systems is built up from n interpenetrating space-lattices, each of the latter being formed from similar atoms occupying parallel positions. All the space-lattices of the combined system are geometrically identical or are characterised by the same elementary parallelepipedon.

Now the combined system of zinc blende is probably that of the type 63 of Sohncke, and $9a_1$ of Barlow, and in their 1907 memoir, already alluded to, Pope and Barlow describe the probable constitution of the crystals of this substance, on the basis of their assumption that the spheres of influence of the zinc and sulphur atoms are approximately equal, the fundamental acting valency of both elements being here considered as dyadic. If the spheres of influence of the zinc and sulphur atoms, or the parallelohedra into which they are compressed when the interstitial spaces are removed in attaining their closest packed arrangement, were quite equal, the symmetry would be cubic holohedral; but the slight difference in size and the different effect of compression on the atoms of the two elements degrades the symmetry into the hexakis-tetrahedral class 31, next lower in the cubic system. This constitution of the crystals of the simple binary compounds, such as zinc sulphide, does not depend, however, on Pope and Barlow's version of the theory of crystal structure; for the sizes of the spheres of influence of the atoms of the two elements are assumed to be approximately equal, just as is the case when valency is not considered to enter into the problem. It is equally the probable one according to the theory of von Fedorow, based on parallelohedra of cubic and hypohexagonal types, which has led him to the remarkable advance in crystallochemical analysis described by the writer in NATURE of July 18 (p. 503); and as the parallelohedron of von Fedorow represents the combined system (that of Pope and Barlow only representing a single atom), its central representative point is a point of the space-lattice itself. The definition of von Groth is thus equally applicable to both versions.

Thus we are dealing with a crystal supposed to be constructed of two interpenetrating regular point-systems (type No. 63 of Sohncke), corresponding to zinc and sulphur atoms respectively; each of these is composed of sixteen interpenetrating space-lattices, each and all formed from one of the two elements only, and composed of atoms of that element occupying parallel positions. All the thirty-two space-lattices of the double or combined system are geometrically identical, and are characterised by the same elementary parallelepipedon, a cube in this case of zinc blende. Hence one type of space-lattice characterises the whole crystal, and it is this space-lattice, *formed by similar* (consisting of the same element) and *similarly situated atoms*, which has apparently afforded the photograph of spots showing holohedral cubic symmetry. This is equally true whether the structure attributed by Pope and Barlow to zinc blende, or a less complicated one, be the correct structure.

These are the crystallographical facts which must be taken into account in any discussion as

[2] Journ. Chem. Soc. Trans., 1907, xci., 1171 and 1178; see particularly Fig. 17 on p. 1171 and Fig. 1 on p. 115..

to the nature of these photographs, which does not appear to have been the case in a letter from Prof. W. H. Bragg, which appeared in NATURE of October 24 (p. 219). It would be very interesting if Prof. Bragg would give a revised account of his views after considering these crystallographic data, with which perhaps only a specialist could be expected to be familiar. For it is quite possible that his conclusions may still prove valid when this has been done. But until then judgment must be suspended.

In further confirmatory experiments the crystal was adjusted so that the primary Röntgen rays fell perpendicularly on an octohedral face (111), and subsequently on a rhombic dodecahedral face (110). In the former case the trigonal nature of the symmetry axis along which the rays passed was clearly revealed by three pairs of spots arranged symmetrically to positions 120° apart, while in the latter case the spots indicated the diagonal nature of the axis by being arranged in two pairs only, 180° apart. When the crystal was rotated a few degrees out of exact adjustment, spots of like character still appeared, but no longer symmetrical to the central large spot, affording another confirmation that it is the space-lattice which is responsible for the photographs.

In his Becquerel Memorial Lecture to the Chemical Society on October 17, the text of which is just published,[3] Sir Oliver Lodge referred in the following words to a brief announcement of the important work of Laue and his co-workers which was made by the writer on his return from Munich in September.

> This, if it be a fact, will have to be recognised as a striking and admirable case of scientific prediction, the various crystalline structures and accuracy of characteristic facets having been indicated by theory long before there was any hope of actually seeing them; so that once more—always assuming that the heralded discovery is substantiated—the theoretical abstraction will have become concrete and visible.

It will now be clear, from the detailed memoirs just published, that the writer's announcement is fully substantiated. Crystallography thus affords to its sister science Chemistry the first visible proof of the accuracy of Dalton's atomic theory, and now enters into a new sphere of still greater usefulness. The important work of von Fedorow on crystallochemical analysis, described in the writer's last communication to NATURE (*loc. cit.*), is based essentially on the assumption of the space-lattice structure of crystals which is now rendered visible to our eyes, for the centres or analogous points of his parallelohedra form either one of the fourteen space-lattices or one of nine simple Sohncke point-systems composed of interpenetrating space-lattices; that work is thereby enhanced in value and placed on an absolutely trustworthy basis. Crystallography has thus become an exact science leading us to a practical knowledge of the hitherto mysterious world where Dalton's atoms and molecules reign supreme.

A. E. H. TUTTON.

[3] Journ. Chem. Soc. Trans., October, 1912, CI, 2078.

GEOPHYSICAL MEMOIRS.[1]

BY the authority of the Meteorological Committee, and under the style and title of Geophysical Memoirs, the publication of a series of investigations has been commenced with the issue of the four "blue-books" before us. It is evident that a high standard of value is contemplated; if possible, higher than that of previous "Reports of Investigations in Dynamical and Statistical Meteorology," which appear in the same section of Meteorological Office publications. We shall look forward with interest to the succeeding memoirs, which represent a genuine attempt to dispel the reproach often cast upon meteorologists as mere collectors of undigested statistics with no real claim to the title of men of science.

The subjects of the memoirs already received are quite independent. In No. 1, the Marine Superintendent of the Meteorological Office (Campbell Hepworth, Commander R.N.R.) discusses the effect of the Labrador current upon the surface temperature of the North Atlantic, and of the latter upon air temperature and pressure over the British Isles. It is interesting, in view of the vagaries of the latter within even the last eighteen months, to find it definitely stated that the much-discussed prevalence of ice in the Atlantic is *not* a cause of cold weather here, but only a symptomatic effect of the cold Labrador current, the meeting of which with the Gulf Stream is held responsible for the notorious fogs off the banks of Newfoundland. The discussion of the data for 1903 to 1907 and for most of 1911 is illustrated by an interesting series of plates giving mean sea-surface isotherms of the North Atlantic for January, April, July, and October, thermo-isopleths for surface temperature between Florida Straits and Valencia (Ireland), mean annual surface temperature for every 2° square in the North Atlantic, and separate diagrams for each of the years under discussion, giving monthly prevalence of ice in the Atlantic measured by 1° squares in which it was observed, the sea temperature, and the air temperature and pressure for three British coast stations, Sumburgh Head, Shields, and Valencia. The author's great experience, both at sea and in the office dealing with the mass of observations communicated from ships, renders his views especially worthy of consideration.

In No. 2, Mr. W. H. Dines, the foremost British investigator of the upper air, continues some previous work with discussions of the vertical

[1] (1) "The Effect of the Labrador Current upon the Surface Temperature of the North Atlantic, and of the latter upon the Air Temperature and Pressure over the British Isles." By Commander M. W. C. Hepworth, C.B., Pp. 10+9 plates. Price 9*d*.
(2) "The Free Atmosphere in the Region of the British Isles. Further Contributions to the Investigation of the Upper Air, comprising the Vertical Temperature Distribution in the Atmosphere over England, with some remarks on the General and Local Circulation: Abstract of a paper printed in Volume ccxi of the Philosophical Transactions, Series A, and Total and Partial Correlation Coefficients between Sundry Variables of the Upper Air." By W. H. Dines, F.R.S. Pp. 11–50+plates 10–12. Price 1*s*.
(3) "Graphical Construction for the Epicentre of an Earthquake." By G. W. Walker. Pp. 51–54+plate 13. Price 3*d*.
(4) "On the Radiation Records obtained in 1911 at South Kensington, together with a comparison between them and the Corresponding Absolute Observations of Radiation made at Kew Observatory." By R. Corless. Pp. 55–61+plate 14. Price 3*d*. (London: H.M. Stationery Office and the Meteorological Office, 1912).

temperature distribution in the atmosphere over England, with some remarks on the general and local circulation (this being an abstract of a paper appearing in the Philosophical Transactions of the Royal Society), and with total and partial correlation coefficients between sundry variables of the upper air. The main conclusions, as we gather from Dr. Shaw's preface to this memoir, are that the upper regions of cyclonic areas are colder than those of anti-cyclonic areas, and that the temperature up to the stratosphere varies in the same direction as the pressure at the surface, and that a close relation exists between the five quantities—pressure at ground level, mean temperature up to nine kilometres, pressure at nine-kilometre level, height of troposphere, and temperature of stratosphere. Illustrations are given of progessive changes in cloud formation.

In No. 3, Mr. G. W. Walker, superintendent of Eskdalemuir Observatory, which has become answerable to the Meteorological Office, gives a graphical construction for the epicentre of an earthquake; and in No. 4 Mr. R. Corless, who, as Dr. Shaw's scientific secretary, is following in the footsteps of such men as Dr. G. C. Simpson and Mr. Ernest Gold, deals with the radiation records obtained in 1911 at South Kensington, together with a comparison between them and the corresponding absolute observations of radiation made at Kew Observatory. We need only remark that it would be more satisfactory for some purposes if a more direct comparison could be made than one between a vertical instrument at one station and a total radiation instrument at another station, operated for only part of the time. Mr. Corless himself emphasises this difficulty, but apart from the comparison with Kew, the actual observations are of great interest, and show among other results the inadequacy of the sunshine instrument as a radiation recorder.

W. W. B.

THE BIOLOGY OF THE FIG-TREE AND ITS INSECT GUEST.[1]

WE take advantage of a recent treatise on fig-culture to enlarge and correct what has hitherto been taught about the biology of the fig-tree and its insect guest, Blastophaga. Our new information is drawn from Dr. Ruggero Ravasini's "Die Feigenbäume Italiens" (Bern, 1911), which gives the results of a prolonged study made in Italy. The research has been directed by Prof. A. Tschirch, of Bern; for the detailed observations and experiments we have to thank Dr. Ravasini, who, in addition to his scientific attainments, enjoys the advantage of being an Italian, and thereby better able to win the confidence of Italian fig-growers. Fig-cultivators and all biologists who make a special study of the fig-tree will, of course, betake themselves to the original treatise, which is clear, interesting, well-illustrated, and not too lengthy. We shall here address ourselves to those biologists for whom a less complete exposition will suffice, at least for the moment.

The structure and life-history of the fig-tree have been modified by long-continued cultivation; and in order to simplify the presentation of the facts, we shall first describe the reproductive process in the wild fig-tree, which still maintains itself in Italy, probably also in all fig-growing countries where the ground is not too closely occupied by cultivation.

The wild fig-tree is monœcious, its unisexual flowers being collected into mixed inflorescences. In remote ancestors of the figs the head may have taken the usual flattish or convex form. Dorstenia, an allied plant, which is now and then seen in hothouses, bears a crowd of small greenish flowers on a flattened disc about an inch wide. In a fig the edges of the disc close in upon the flowers, and we get a hollow, pear-shaped receptacle lined with minute, crowded, unisexual flowers. The opening is not only narrowed, but further obstructed by outward-pointing scales. During ripening the wall of the receptacle becomes thickened, and the central cavity almost disappears. In Dorstenia the small fruits are shot out by the turgidity of the wall; in the figs the wall may become eatable, and promote the dispersal of the seeds in another fashion.

The wild fig-tree bears three different kinds of inflorescence, according to the season of the year. There is a *spring inflorescence*, bearing male and sterile female flowers; a *summer inflorescence*, which bears only fertile females; and a *wintering inflorescence*, which bears only sterile females. Sterility here results from the adaptation of female flowers to the nutrition of fig-wasps (Blastophaga); the sterile flowers are hence called *gall-flowers*. In the cultivated fruiting fig-tree sterile pistillate flowers of another kind occur.

The process of pollination of the fig by Blastophaga is comparatively familiar, but it may be briefly described here to save the necessity of reference to books. Blastophaga is a small Chalcidid hymenopterous insect. The male is wingless, and the female (which alone passes from one inflorescence to another) winged. In spring, impregnated females issue from the wintering inflorescence and fly to the spring inflorescence. Here they lay eggs in the gall-flowers, one egg to each flower, and from these eggs both male and female flies proceed. When full grown, the male crawls sluggishly about until he becomes aware of the presence of a female still enclosed within the ovary of a gall-flower. Then he bites a hole in the ovary, passes in the tapering, pointed end of his abdomen, and effects his purpose. Since the male rarely quits the inflorescence, he has no need of wings or eyes; accordingly there are no wings, and the eyes are poorly developed; even the antennæ are small and few-jointed; the mandibles, however, and two of the three pairs of legs, are powerful.

The winged female after impregnation bites off the top of the ovary, and makes her way into

[1] "Die Feigenbäume Italiens und ihre Beziehungen zu einander." By Dr. Ruggero Ravasini. Pp. 174+6. (Bern: Max Drechsel, 1911.) Price 11 marks.

the central cavity of the spring inflorescence. The staminate flowers, set in a ring round the outlet, are now ripe, and the issuing female gets dusted by their pollen. Then she flies to the immature figs of the summer generation (we are still speaking of the wild fig-tree), which contain only female flowers. In her fruitless search for gall-flowers in which to lay her eggs, she pollinates the female flowers. So many Blastophagas are deceived by appearances that whenever a wild fig-tree is shaken in July or August, swarms of the flies come out of the summer figs. Is it possible that they procure food for themselves there?

Ravasini shows that in the wild fig-tree there are only two sets of gall-flowers, one in the wintering, another in the spring inflorescences. He believes that there are also only two sets of Blastophagas, answering to the two sets of gall-flowers. One female Blastophaga may suffice for an entire inflorescence, so that there is a great superfluity of insects.

In October the wintering inflorescences are ready, and the later-hatched Blastophagas of the spring generation enter them to lay their eggs in the gall-flowers. The life-cycle of the insect is thus completed.

We must now add a few words about cultivated fig-trees.

When men began to plant wild fig-trees in their gardens, they would, of course, propagate them by cuttings. Now cuttings of the wild fig-tree are found to reproduce the characters of the *branches* from which they were taken. By taking cuttings from branches destined to bear spring inflorescences, trees have been produced in which only the spring inflorescences regularly attain complete maturity; these trees are Caprifigs (goat-figs), which are practically male. In the same way, by using as the parent stock branches which bear summer inflorescences, trees have been produced which are entirely female. Of these two the caprifig alone is capable of harbouring the insect guest during its growth period.

Two fig-trees, very different in appearance and function, have thus been developed by the action of man out of the single primitive stock; they are often called '*varieties*, but Tschirch and Ravasini show that they are really *artificially produced sexual forms* of one and the same natural species, viz. of the wild fig-tree. One proof is that seeds of the cultivated fig-tree produce either caprifigs or inferior fruiting figs. A further proof is yielded by the fact that the female Blastophaga, when laden with eggs, can only fly a very short distance. Hence we infer that she is adapted to a monœcious fig-tree, in which all the forms of inflorescence are to be found on one tree. The cultivated fig-tree is practically diœcious, and without artificial pollination ripens no seed. Only one monœcious tree is known, which can be regarded as a possible common ancestor of the two interfertile forms, caprifig and fruiting cultivated fig; this common ancestor is the wild fig-tree.

Fig-cultivators must have become early acquainted with the Blastophaga and the effects of its visits, for the female flowers of the fig remain unfertilised if no Blastophaga enters them, and unfertilised female inflorescences (in unimproved fig-trees) fall off prematurely. To prevent such failures, the expedient was successfully tried (ages ago) of fastening to the female trees ripe staminate inflorescences of the wild fig-trees. Blastophagas and pollen were thus supplied together, and the female inflorescences duly ripened. In course of time the inflorescences of the wild fig-tree were replaced by those of the caprifig, which answer the same purpose, and are easily raised on the spot. Thus arose the practice of "caprification," which is essential to the production of the best keeping or drying figs.

The dried figs of commerce, which are all seed-bearing, absolutely require fertilisation by the Blastophaga, and this is most easily secured by caprification. But if only *fresh* edible fruits are desired, caprification may be dispensed with. By long-continued selection it has been found possible to create varieties in which the unfertilised figs do not fall off prematurely, but develop into a valuable fruit. The large, non-seeding, sweet and juicy table-figs of north and mid-Italy require no pollination at all. Ravasini calls this the greatest triumph of fig-culture.

We have not explained all that we should like to explain, but enough, we hope, to send some of our readers to "Die Feigenbäume Italiens," and to make them look out for the further experiments which Dr. Ravasini promises.

L. C. M.

NOTES.

THE next meeting of the International Union for Solar Research will be held at Bonn on Friday, August 1, 1913, and succeeding days.

A REUTER message from Stockholm announces that the Swedish Royal Academy of Sciences has awarded the Nobel prize for physics for 1912 to M. Gustaf Dalen, a Swiss engineer, the head of the Stockholm Gas Company, and the prize for chemistry has been divided between Prof. Grignard, of Nancy University, and Prof. Sabatier, of Toulouse University.

THE council of the Royal Scottish Geographical Society has resolved to award the Livingstone gold medal to Captain Roald Amundsen and the society's silver medal to Captain Egnar Mikkelsen, the leader of the Danish expedition to north-eastern Greenland, in recognition of their services to geographical science.

WE are glad to learn that the Chilean Government has sent instructions to the Chilean authorities at Easter Island to afford every assistance in their power to the expedition organised and led by Mr. and Mrs. W. Scoresby Routledge. The main object of this carefully planned and well-equipped expedition is to make a topographical and archæological survey of Easter Island, the most remote of Polynesian islands, which is famous for its megalithic monuments, of which visitors to the British Museum have seen examples in the portico. There are many problems of extreme interest concerning the culture of the natives, of whom it is said no pure-bred descendants now exist. Mr. Routledge and his colleagues have a most fascinating field for research, and we wish them every success.

WE regret to notice the death, in his eighty-first year, on November 6, at the University of Virginia, U.S.A., of Prof. J. W. Mallet, F.R.S., professor of chemistry in the University, and joint author, with his father, of the British Association catalogue of earthquakes.

THE death is announced, at the age of ninety years, of M. Aimé Pagnoul, a French authority on agricultural chemistry. In 1869 M. Pagnoul organised the agricultural station of the Pas-de-Calais, of which he was director until 1899; and in 1894 he was elected a correspondant of the Paris Academy of Sciences in the section of rural economy.

THE Decimal Association announces that a large majority of American jewellers has agreed to adopt the metric carat of 200 milligrams as from July 1, 1913. A committee has been formed to promulgate the passage of a law making the metric carat effective throughout the country. It is probable that the adoption of this new carat by the jewellers of the United States will hasten its introduction here.

THE 159th session of the Royal Society of Arts will be opened on Wednesday evening, November 20, by Lord Sanderson, G.C.B., K.C.M.G., chairman of the council, who will deliver an address and distribute the medals awarded last session. Mr. A. Zimmermann will describe "The Manufacture of Sugar from Wood, and its Economic Importance," on December 4, and Dr. F. Mollwo Perkin will read a paper on synthetic rubber on December 11. In the Colonial Section, Prof. W. H. Warren will describe "The Hardwood Timbers of New South Wales" on November 26. A course of Cantor lectures will also be delivered by Mr. C. R. Darling on "Methods of Economising Heat" on Mondays, December 2, 9, and 16.

THE following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1913 at the anniversary meeting on November 30:—*President*, Sir Archibald Geikie, K.C.B.; *Treasurer*, Sir Alfred B. Kempe; *Secretaries*, Sir John Bradford, K.C.M.G., Prof. A. Schuster; *Foreign Secretary*, Dr. D. H. Scott; *Other Members of the Council*, Lieut.-Col. A. W. Alcock, the Right Hon. A. J. Balfour, Sir William Crookes, O.M., Dr. F. W. Dyson, Prof. W. Gowland, Sir Joseph Larmor, Prof. E. W. MacBride, Mr. W. B. Hardy, Prof. Micaiah J. M. Hill, Sir Ronald Ross, K.C.B., Prof. G. Elliot Smith, Prof. A. Smithells, Dr. J. J. Harris Teall, Prof. Silvanus P. Thompson, Prof. Sir J. J. Thomson, Sir Philip Watts, K.C.B.

THE Zoological Society of Los Angeles, California, was established in August, 1911, to further the project of starting a collection of wild animals in Griffith Park in that city, and we are glad to learn from the first number of its Proceedings that the idea has already taken practical shape. The necessary funds are being raised by private subscription, aided by a substantial grant from the City Council. Judging from the description, the site and climate seem to offer ideal conditions for the exhibition and preservation of animals in extensive ranges, varying in area from fifteen to one hundred and twenty-five acres. To this is to be added a marine aquarium to be placed on the sea-front on the cliffs skirting the base of San Pedro Hill. To zoologists will be especially welcome the announcement that although the animals are to be kept primarily as part of the park system for the pleasure and instruction of the people, a special feature of the institution will be a prosectorial department, where the anatomy and pathology of the dead animals may be investigated. We heartily wish the project all success.

A COPY of the programme for 1912 of the Société Batave de Philosophie expérimentale de Rotterdam has been received. The gold medal of the society, or its value in money, as the successful candidate may determine, will be awarded to each candidate whose paper on a scientific question proposed by the society is considered most satisfactory by a general meeting of members. The programme includes some forty-five questions to which competitors may address themselves. The general character of the inquiries proposed by the society may be gathered to some extent from the following examples: an anatomical and physiological description of one or more species of a family of plants which up to the present has not been examined satisfactorily in this way; magnetic variations and disturbances; an exact and critical review of our present knowledge of the volcanoes and volcanic phenomena in the East Indies; an experimental research into the thermoelectric properties of some metallic alloys, with special reference to the influence of the composition of the alloy; a study of the origin, physiological significance of the green colouring matter in the bodies of certain animals, structure and development of a species of trypanosome, &c. The theses may be written in Dutch, French, German, or English, and should be in the hands of the secretary of the society by February 1, 1914.

ON November 7, a conference of museum curators and others interested in museum work was held at the Manchester Museum. Mr. H. W. Freston, chairman of the Manchester Museum Standing Committee, presided, and representatives from twenty-eight museums were present. In a paper on pigmy flint implements, Mr. W. H. Sutcliffe, of Rochdale, maintained the opinion that the shouldered type of these implements was used by Neolithic man to form a kind of carding tool, by fixing numbers of them up to the shoulder in a wooden stock, with which the muscle fibres and sinews adhering to skins used for clothing could be teased and loosened after curing, the skin being rendered by this means soft, pliable, and capable of being made into close-fitting garments. The chief opposition to this theory was based on the grounds (1) that no trace of wooden stock had ever been found with pigmy flints; (2) that only a small percentage of the flints showed any signs of wear or usage; (3) that the fine sharp points of the majority suggested their use for some such purpose as tattooing. Mr. Sutcliffe replied to these objections as follows:—(1) That, from the analogy of other Neolithic implements, such as hammers and axes, in which the use of a wooden haft was postulated, though traces of such a haft were seldom found, the objection on this ground failed; (2) that in his experience 46 per cent. of the flints were blunted and worn; and (3) they were much more numerous than one would expect tattooing implements to be.

THE Smithsonian Institution has just issued three papers describing further new material collected during the biological survey of the Panama Canal zone, including new insects, mammals, and birds. This survey was inaugurated in 1910 and carried on for two seasons. Early this year Mr. E. A. Goldman, of the Biological Survey, U.S. Department of Agriculture, went to Panama for the second time and made additional collections of mammals. The collection of natural history specimens, which includes some 800 birds and 595 mammals, indicates that the fauna of eastern Panama is South American in its general characteristics. The new birds of the region have been described by Mr. E. W. Nelson in a pamphlet entitled "Descriptions of New Genera, Species, and Subspecies of Birds from Panama, Colombia, and Ecuador." Many of the specimens were collected by Mr. Goldman, who seems to have been the first zoological collector to have penetrated the forests about Mount Pirri and its bordering lowlands. Here many birds and mammals not before known from Panama were taken, a number of which were also new to science. Several species of South American animals appear to reach their northern limit at this point, being unknown in the Canal zone and the adjacent territory, although only about 150 miles distant. Mr. J. R. Malloch, of the Bureau of Entomology, Department of Agriculture, has written a technical description of three new species of Diptera from Panama. The three papers just issued are Publications Nos. 2141 to 2143 in the Smithsonian Miscellaneous Collections.

A RECENT number of the "Annals of Tropical Medicine and Parasitology" (vol. vi., No. 3) contains a memoir by Drs. J. G. Thomson and J. A. Sinton on the morphology of *Trypanosoma gambiense* and *T. rhodesiense* in cultures, with a comparison between the cultural forms and those known to occur in the natural development that takes places in the tsetse-fly (*Glossina palpalis*). The life-history of these trypanosomes in culture-tubes was found to be similar to that which occurs in the gut of the insect-host. An interesting parallel with the natural development was further shown in the fact that the cultures of the trypanosomes quickly lose their infectivity, and after the third day are not infective to rats by intraperitoneal injection. In the cultures the trypanosomes do not regain the infectivity which in tsetse-flies they acquire again by passing into the salivary glands of the fly. The authors found no evidence of a sexual cycle, although the so-called "male" and "female" forms are present in the cultures.

FROM a small guide-book compiled by Mr. T. Sheppard, we learn that the town of Scunthorpe, Lincolnshire, situated in the heart of the ironstone district, possesses a small museum, which is specially devoted to local palæontology, antiquities, and natural history. The guide contains illustrations of ironstone fossils, prehistoric implements, and ancient Roman vases.

FROM the report of the Inspector of the Eastern Sea Fisheries for the year ending September 12, it appears that during the period under review not only has the catch been for the most part unsatisfactory—largely owing to bad weather—but that on the Norfolk and Suffolk coast foreign trawlers are alleged to have approached too near the land, while on the Lincolnshire coast several steam-trawlers are stated to have run the risk of being caught at work within the territorial limit. As complaints are rife—as, for instance, at Torbay—with regard to the depletion of fisheries by our own trawlers, it is only justice to our fishermen that they should be adequately protected from foreign poaching.

THE first volume of the second series of the Memoirs of the American Museum of Natural History commences with a description by Prof. H. F. Osborn of the skull of the gigantic theropod dinosaur *Tyrannosaurus rex,* from the Upper Cretaceous of Montana, together with notes on the skulls of Allosaurus and the Theropoda in general. The skull of Tyrannosaurus, which is furnished with a formidable armature of teeth of the megalosaurian type, is not only the largest in the theropod order, but, speaking generally, is also the most powerful and massive among reptiles as a whole; this may be verified by the inspection of a cast exhibited in the fossil reptile gallery at the Natural History Museum. A noteworthy feature is the fusion of the vomers into a single diamond-shaped plate, articulating posteriorly by a long style with the pterygoids, since a practically identical structure exists in the ostrich group. As an adaptive modification correlated with the powerful dentition, attention is specially directed to the antero-posterior shortening of the skull and the reduction of the number of pairs of teeth from twenty (in Allosaurus) to sixteen. This abbreviation of the skull is paralleled among modern cats and certain extinct dog-like carnivores. The homology of certain bones of the theropod skull is also discussed. In a second article in the same issue Prof. Osborn describes in detail, with photographic illustrations, the skin of the iguanodont dinosaur *Trachodon annectans,* from the Upper Cretaceous of Wyoming, as preserved in a "mummified" skeleton. Since reference was made last year in NATURE to a preliminary account of this wonderful specimen, further notice is unnecessary.

WE have received four parts of the zoological reports on the collections made by the Duke of Orleans in his Arctic expedition on the *Belgica* in 1907. ("Campagne Arctique de 1907." Duc d'Orléans. Bruxelles: C. Bulens, 1911–12.) The Siberian Sea, along the coast of Nova Zembla, has not been much explored, and these handsomely got-up volumes contain many interesting records and descriptions. Dr. Louis Stappers deals with the higher Crustaceans, and attention may be directed to the very fine figures illustrating species of Leptostylis. Prof. Pierre Fauvel reports on the Annelids, of which fifty-two species were collected. It is interesting to notice that only one of these was new, namely *Sphaerodorum philippi*. It appears that almost all the boreal Annelids are represented throughout the circumpolar area, and it is remarkable that some occur so far south as the Azores, the Mediterranean, and the Indian Ocean. The Bryozoa are discussed by O. Nordgaard, who reports the occurrence of sixty species in the Kara Sea alone. From a single station twenty-seven species were obtained, and the abundance of superb specimens of *Reticulipora* (*Diastopora*) *intricaria* is a conspicuous feature in many places. It seems that Bryozoa flourish particularly well in localities with a rapid current and abundant plankton organisms. The great majority of the species collected by the *Belgica* are distinctively Arctic, a number are boreal, three are almost cosmopolitan. Dr. Hjalmar Broch reports on the Cœlentera—twenty-six Hydroids, five Alcyonarians, and two sea-anemones. In some cases the occurrence is of great interest as regards the geographical distribution of the species. Thus *Eunephthya clavata*, reported from the Kara Sea, has also been recorded from the Azores.

A REPORT on the structure and development of crown gall, a plant cancer, by Mr. E. F. Smith and Misses N. A. Brown and L. McCulloch, has been issued by the U.S. Department of Agriculture (Bureau of Plant Industry, Bull. 255). The disease attacks a variety of plants, is infectious, and is caused by bacteria, either one polymorphic species, or several closely related species. A full description of the organism, named the *B. tumefaciens*, and of its cultural and biological characters is given. The development of the disease is regarded as closely simulating what takes place in cancer of man and animals, though metastases do not occur, and, of course, this disease of plants has nothing to do with mammalian cancer. The report is illustrated with no fewer than 109 full-page half-tone plates.

FROM Dr. C. R. Wieland we have received reprints of four papers contributed to *The American Journal of Science*, containing the results of his further observations on the fossil Cycads, and thus forming a supplement to his great work on "American Fossil Cycads," published in 1906. In a note on seed structure in the Cycadeoideæ (Bennettitales), the author remarks that the seed and embryo of these Mesozoic forms are of the most generalised gymnospermous type, while their retention of pronounced cycadofilicinean features further favours inclusion in the Cycadales; apparently the primitive seed characters of the Cycadeoideæ were only slightly obscured by appression in the cone type of fructification, and were by this very appression so much the more surely conserved as to permit free comparison with the ancestral singly-borne leafy seeds of the Palæozoic forms. Another note is devoted to the mature but pigmy flowers of *Cycadeoidea Marshiana*, and to a discussion of the probable relationships between Cycadeoideæ, Cycads, Cycadofilices, and Gnetales. A third paper deals with the author's own examination of certain historic fossil Cycads described by earlier writers; while the fourth contains a general review of the Williamsonia and Cycadeoidea tribe, with special reference to types recently discovered in Europe, and a provisional classification of the forms now known.

THE Patent Office has isued part i. of a "Subject List of Works on Mineral Industries" (Darling and Son, price 6*d*.), which shows how much good material is available for public consultation in the library in Chancery Lane, London. In this part the geological sciences and coal mining are included, and mineral industries and practical mining come under these heads. The detailed classification adopted prevents the ready discovery of books on a given subject, since several headings may be consulted in vain before the right one is discovered. Rutley's "Felsitic Lavas" thus appears under "Lavas" and not also under "Petrology"; his Brent Tor memoir is found under "Petrology, Igneous Rocks," and not also under "Geology, Descriptive, Devonshire." The division of geology into economic, descriptive, and stratigraphic renders the publications of geological surveys extremely hard to classify. A few repetitions and cross-references are conveniently introduced; but the memoirs on the South Wales coalfield appear under none of the above headings, not even under "Economic—local—Wales," but only under "Coal, Distribution." Hardman's memoir on the Leinster coalfield seems to have no separate mention, and there is no heading "Carboniferous" under "Geology, Stratigraphic." The miner comes off somewhat better, with good lists of works on nitrates, phosphates, &c.; but a far broader classification, with sub-headings alphabetically arranged, will be of much service to the reader when the list is next revised.

THE aggravating contrast between the heavy rainfall on the rugged eastern highlands of Australia and the arid climate of the rich-soiled plains to the west has led to many projects for the more useful distribution of the water. The most important scheme in New South Wales is that for collecting the winter floods of the Murrumbidgee River for use during the summer by the construction of a vast reservoir with a dam 240 ft. in height. The reservoir will be one of the greatest in the world, as it will hold 33,000,000,000 cubic feet of water, or a greater amount than that contained in Sydney Harbour. The water will be conducted by channels, which may amount to 1000 miles in length, and be used for the irrigation of a large area more than 100 miles to the west. The reservoir is in a locality hitherto known as Barren Jack; this is a corruption of an aboriginal name, Burrinjuck, which has been officially adopted. The New South Wales Government is advertising for applicants for the land which can thus be brought into cultivation, and has issued a pamphlet, by Mr. L. A. B. Wade, the chief engineer for irrigation and drainage, on the progress of the work.

THE *Mitteilungen* from German Protectorates (vol. xxv., part 3, 1912) contain the monthly and yearly summaries of the meteorological observations at stations of the second order, and at the rainfall stations in Togoland (equatorial West Africa) for the year 1911. The summaries have been very carefully prepared by Dr. P. Heidke, of the Deutsche Seewarte, and include in the accompanying text much valuable information relating to the climate of that district. It is satisfactory to note that the observers take much interest in their work; at many stations they have considerably exceeded what was required of them.

No better evidence of the paucity of scientific knowledge amongst Englishmen supposed to be well educated has ever been afforded than was given in the House of Commons during the discussion of the Bill for the adoption of the metric system five years ago. A responsible Minister of the Crown then stated that "the metric system had broken down in France," and the House appears to have believed him. To those whose information on the subject is not up to date, an article by Dr. C. E. Guillaume in the *Revue générale des Sciences* for October 15 will be of great value. It shows that the other systems have almost entirely disappeared, the only ones at present in use being the Anglo-Saxon, the Russian, and the Japanese, while Japan has recently adopted the decimal system with a view to further reform in the near future. Australia, New Zealand, and South Africa are anxious that the British Empire should adopt the system, and it begins to look as if the Mother Country would be left in sole possession of a system which the average man finds so difficult to remember that he cannot say how many multiples a pound or an ounce is of a grain, or a mile of a yard, or what is the definition of a gallon.

THE Proceedings of the University of Durham Philosophical Society for 1911–12 (vol. iv., Pt. 4) contains the following papers:—The stability of a floating triangular prism, Mr. F. H. Alexander; the effect of soil aeration on plant growth, Mr. C. Hunter; chemical reactions taking place at the kathode and anode during the electrolysis of simple salt solutions, Dr. J. H. Patterson; the preparation of benzyl mercaptan, Dr. J. A. Smythe; the preparation of acrylic ester, Dr. F. G. Trobridge; some para derivatives of phenylacetic acid, Mr. S. Robson; analysis of a Florida Clay, Dr. A. A. Hall; and the rate of fermentation as measured by difference of potential, Dr. M. C. Potter. The society includes 171 members, and held 21 meetings, at which 20 papers were read, during the session 1911–12. The sixth report of the Boulders Committee is printed in the present issue of the Proceedings.

MR. ROBERT ELLIOTT-COOPER'S presidential address to the Institution of Civil Engineers is largely composed of an interesting discussion of the labours of the civil engineer in the oversea dominions of the British Empire. Dealing with the Grand Trunk Pacific Railway in Canada, while there is much to admire in this huge undertaking and its accessories, there is one matter which will not find general acceptance in these days of picturesque town-planning, except perhaps from those who think, with Ruskin, that railways and æstheticism are absolutely irreconcilable. The new townships which have been and are about to be established along the undeveloped lengths of the new line are, as nearly as possible, eight miles apart, centre to centre, and are all on the northern side of the railway. In each town is one main street, named so in every case, 80 ft. wide, and leading up to the precise centre of the station, while there are 60-ft. streets at exactly equal distances apart on a chess-board pattern, completing a perfect square. A few of these perhaps would not affect the traveller much, but, when 1000 miles covering 125 towns of this description are passed, it will take all the sublime diversity of the scenery of the Rocky Mountains to soothe his irritated nerves.

MR. JOHN MURRAY has published a translation by Mr. W. C. Clinton of Dr. L. Bloch's "Science of Illumination," which was reviewed in these columns on March 7 last (vol. lxxxix., p. 3). With the consent of the author, Mr. Clinton has made certain alterations and additions rendered necessary by the difference between the English and German units and standards, and by the lapse of time. The price of the English edition is 6*s*. net.

MR. FRANCIS EDWARDS, bookseller, of 83 High Street, Marylebone, London, W., has issued a catalogue of the geographical library of Mr. Ernest G. Ravenstein. The catalogue includes some 1197 entries of works which he has for sale. Messrs. Bowes and Bowes, 1 Trinity Street, Cambridge, have published a catalogue of books on pure and applied mathematics which they have on sale. The list deals with mathematical histories and dictionaries, mathematical works published before 1700, and works of reference.

OUR ASTRONOMICAL COLUMN.

THE BRAZILIAN ECLIPSE, OCTOBER 10.—We learn from Mr. J. H. Worthington that his private eclipse camp in Brazil was in the same locality as that of the Greenwich observers, and that rain entirely prevented observations. He further states that it would probably have been necessary to travel at least a thousand miles to escape the rain zone on the day of the eclipse.

BORRELLY'S COMET 1912*c*.—Circular No. 137 from the Kiel Centralstelle gives a set of elements and an ephemeris for the comet discovered by M. Borrelly on November 2. From these we see that the comet passed perihelion on October 22, when it was some 103 million miles from the sun, and is now travelling southwards through Hercules towards Aquila; on November 18 it will be about 25 m. east of ϵ Aquilæ. The distances from both the sun and the earth are increasing, and consequently the calculated magnitude, now 8·7, is decreasing.

In a letter in *The Times* of November 13, Mr. W. S. Franks states that the comet was observed on November 9 at Mr. F. J. Hanbury's observatory, Brockhurst, East Grinstead, with the 6-in. equatorial. "At 8.10 p.m., November 9, its approximate right ascension was 18h. 37m., and declination 27° 33′ N. It was fairly bright, and estimated as of about seventh magnitude, being easily visible in the finder. It was judged to be about 1′ of arc in diameter, gradually brightening to the centre, but without a nucleus."

THE LIGHT-CURVE OF NOVA GEMINORUM, NO. 2.—The results of about 270 magnitude-observations of

Nova Geminorum, No. 2 (1912), made between March 12 and the end of May, are published and discussed by Herr J. Fischer-Petersen in No. 4608 of the *Astronomische Nachrichten*. The light-curve shows oscillations somewhat similar to those of Nova Persei in 1901, but of less amplitude and longer period. The maximum magnitude, 3·8, was reached on March 14, and then there was an abrupt fall, to 5·4, on March 16; subsidiary maxima occurred on March 24, 30, April 3 and 9, that on the first-named date being very marked (mag. = 4·8). After April 9 the undulations of the curve are very small.

THE DARK STRUCTURES IN THE MILKY WAY.—An interesting paper full of suggestion as to the structure of the universe is contributed by the Rev. T. E. Espin to No. 4, vol vi., of the Journal of the Royal Astronomical Society of Canada. Mr. Espin recalls Caroline Herschel's idea that a blank region in Scorpio was believed by Sir William Herschel to indicate "something more than a total absence of stars," and then, by the examination of other blank regions, he proceeds to show that in all probability there exist in the heavens masses of dark, light-absorbing vapours, which hide from us the light emitted by stars or parts of nebulæ in the background. The photographic evidence seems almost irrefutable, it being difficult to explain otherwise such observations of Dr. Kopff's that "nearly all faint stars have disappeared from the immediate surroundings of these nebulæ, though they are ten times more numerous, both in the nebulæ and far outside." But if we suppose the bright nebulæ which are shown on our photographs to have margins which are too diffuse to become illuminated, yet dense enough to absorb, the difficulty is removed, and if this absorbing margin, or extension, is projected, by the position of our view-point, on to the main body of the bright nebula, the "holes" and "lanes" observed in such nebulæ are similarly explained. A number of beautiful photographs to illustrate Mr. Espin's article are reproduced.

Dr. Chant also has a paper in the same journal, dealing with nebulæ and their forms, and this, too, is illustrated by many interesting reproductions.

STELLAR ACTINOMETRY AT THE YERKES OBSERVATORY.—A paper of great importance to astrophysicists and workers in stellar photometry is published by Mr. J. A. Parkhurst in No. 3, vol. xxxvi., of *The Astrophysical Journal*. For many years Mr. Parkhurst has been working on the relations existing between photographic and visual magnitudes, and has published details of a method whereby both could be measured photographically. He now publishes the results of a much more extended research, and gives both the photographic and visual magnitudes for some 650 stars, down to magnitude 7·5, in the Potsdam Photometric *Durchmusterung*, from 73° to the pole. The photographic magnitudes were measured from extra-focal images on Seed 27 plates, and the "visual" from reflector plates taken in the focus on colour-sensitive plates, and with a specially prepared colour-filter; Mr. Parkhurst fully describes the ingenious methods of eliminating or determining the numerous errors inherent to the observations. Then in his catalogue he gives the colour index of each star and, where possible, the type of spectrum; comparisons with the results obtained by other observers show fair agreement. The relation between spectrum and colour index, using the Harvard classification for the former, is best represented by a straight line, the differences being so slight as not to warrant the introduction of any complex curve to show the relation. There were 492 stars in this catalogue bright enough to give spectra which could be classified, and, of these, exactly half belong to the types B_2 to F_0, and half to types F_1 to M; 196, or 40 per cent., are of the A type. At the nearest approach to the galaxy, viz. 10° in R.A. 1h., each field showed some ten or twelve white stars, while at the greatest distance from it, viz. 44° in R.A. 13h., there were only two or three white stars per field.

THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute, which was held at Leeds on September 30 and October 1–4, may fairly be described as a "practical man's" meeting, for although the programme contained approximately an equal number of "practical" and "scientific" papers, those read and discussed at the meeting belonged entirely to the former class. While this is no doubt satisfactory to a large number of members of the institute who take rather less interest in scientific metallurgy than might fairly be expected of them, it is rather hard on the authors of scientific papers and on those members who were attracted to the meeting by the array of such papers on the programme. It is true that on other occasions the programmes have erred in the opposite direction, and it may be hoped that at future meetings a judicious blending of both types of papers may be brought up for discussion.

Among the papers relating to steel-works practice, the greatest interest and importance attaches to those dealing with the question of the production of sound ingots. Sir Robert Hadfield, F.R.S., who presented papers on a method of producing sound ingots and on a new method of revealing segregation in steel ingots, introduced the subject by referring to the series of alarming rail-fractures which had occurred in America during the exceptionally severe weather of last winter. These failures, and others which occur under less severe conditions, he is inclined to ascribe to unsoundness in the steel ingots from which the rails are rolled. According to the treatment and additions which a steel has received, the resulting ingot may suffer from unsoundness of one of two distinct types; the ingot may be more or less full of cavities or blow-holes of varying size and distribution, and in that case it is a non-settling, non-piping steel in which gases have been liberated during solidification in the mould. On the other hand, by suitable additions of small quantities of silicon or of aluminium, the steel may be rendered "solid" or "settling" in the sense that the ingot will be free from blow-holes or small distributed cavities, but it will—in the absence of special treatment—have a deep central cavity or "pipe," the existence of which results either in the discarding of a large proportion of the finished steel by the rejection of the upper portion of the ingot, or, if the piped portion is not sufficiently discarded, an unsound rail may be rolled from it, possibly with disastrous consequences.

In one of his papers Sir Robert Hadfield suggests a method of studying the formation of such pipes by pouring molten copper into the ingot at a certain stage of its solidification. He illustrates this method by coloured sections of ingots thus treated, but in the discussion Dr. J. E. Stead, F.R.S., pointed out that the copper when poured in will partly alloy with the still molten steel, and will then, by its greater density, produce an upward displacement of the remaining liquid steel, so that Hadfield's pretty method is really only applicable if the copper is introduced immediately after the complete solidification of the steel. Even if introduced earlier, however, the copper makes it possible to trace the order in which the various parts of an ingot have solidified, and even that information is of some importance.

Sir Robert Hadfield's method for producing sound ingots consists in producing solid "piping" steel, and then arranging matters in such a way that the tendency to form a pipe is neutralised by a full supply of hot liquid steel from above. This is attained by attaching to the top of the ingot-mould a "feeding head" lined with sand; this practically constitutes an upward continuation of the ingot-mould, and when the mould is filled the steel is allowed to rise to some distance into this attachment. The steel in this feeding-head is, however, to be kept molten until the solidification of the ingot proper is completed, and this is attained in Hadfield's process by covering the surface of the steel first with a thin layer of cupola slag, which serves to protect the metal against both thermal loss and chemical contamination, and then with a layer of charcoal, which is brought into a lively incandescence by the action of a blast of compressed air. The author gives numerous examples and full particulars of results attained in this way, and although in the discussion on this subject doubts were expressed as to the practicability of the process, and to some extent as to its novelty, its efficacy was admitted.

Another method intended to serve the same purpose of producing sound ingots was described by Dr. Hans Goldschmidt, who claims for it favourable results with thousands of actual ingots. This method consists in the introduction into the central, fluid part of a partially solidified ingot of a cartridge of "thermit." The amount of thermit used is small—about one pound per ton of steel—so that the heat generated is strictly local and quite negligible. The introduction of the thermit cartridge, which consists of an iron canister pushed down with an iron rod, results in a boiling or frothing up, followed by a settling of the steel in the mould, this shrinkage being made good by the addition of a further small amount of molten steel from the ladle. The author suggests that the thermit reaction taking place near the bottom of the solidifying ingot results in the removal of gas and of entangled slag, but this point of view was not at all appreciated in the discussion; in fact, Dr. Goldschmidt's proposals were scarcely taken seriously. Thus Stead suggested that the addition of a small amount of aluminium to the steel in the ladle would produce the same effects—a suggestion strongly repudiated by Goldschmidt. In view of the large amount of practical evidence brought forward in the paper, this treatment was a little surprising.

In the course of the discussion on these papers, Dr. J. E. Stead described a method introduced by Talbot for the production of sound ingots. In this process the ingots are passed through the "cogging mill" before their interior portions have become solid, and in this way the wider end of the ingot is compressed and the liquid steel is forced to fill up any shrinkage cavities which might be in course of formation. In principle this process is similar to the Harmet method of compressing steel ingots during their solidification, but if it proves to be practicable to handle and lightly roll ingots consisting of molten steel with a mere external crust of solidified metal, the method may justify the enthusiastic predictions of its sponsor. Talbot's own account of his procedure, with the statistical data demanded by Hadfield, will, however, be awaited with interest.

Among the more scientific papers which were taken as read at the meeting, the most interesting from the general point of view is that of Benedicks on allotropy in general and that of iron in particular. In this paper the author begins by raising the question whether allotropic or polymorphic changes are necessarily sudden, *i.e.* whether they must occur at one definite temperature or whether they may in certain cases occur continuously over a certain range of temperatures. He arrives at the latter conclusion, and expresses it by saying that all degrees of mutual solubility of the two allotropic modifications in one another are theoretically possible. In the case of a considerable mutual solubility an allotropic "transformation point" would cease to exist, but where the solubility is one-sided, the modification ii. being slightly soluble in the modification i., but not *vice versa*, there would be a gradual change upon one side of the transformation point with a large sudden change at that point itself. By means of accurate dilatometric measurements on silver iodide, Benedicks shows that the transformation of this body is of the type just indicated, the curve of dilatation giving the precise shape required on the assumption that the high-temperature modification is to some extent soluble in the low-temperature modification at temperatures just below the transition point, the solubility decreasing with falling temperature. This accounts for the negative dilatation at room temperatures.

When this view is applied to the case of iron, the author considers that the critical point at or near 890° C. is a definite allotropic change-point, but he does not regard beta iron as a separate allotropic form, explaining the existence of the beta range on the basis that gamma iron is soluble in alpha iron to an extent which increases with the temperature until the critical point is reached. Benedicks considers that this view would greatly simplify the metallography of iron, since it would reconcile the three theories now accepted as most probable regarding the nature of martensite. This interesting paper would undoubtedly have given rise to one of those spirited discussions for which this particular subject is noted, and it is a pity that so important a communication should have been passed over; it may be hoped, however, that it will receive full attention in the discussion by correspondence which forms so interesting a feature of the Journal of the institute.

HEREDITY AND EUGENICS.

The third and last number of *The Mendel Journal* contains an interesting article on the alternative heredity of mental traits, by Dr. Frederick Adams Woods, of the Massachusetts Institute of Technology. Dr. Woods's previous studies of heredity as exemplified in Royal families attracted a great deal of attention, and the present short paper based on the same class of material is well worthy of study. He advances the argument that the contrasts shown in the characters of children born of the same parents and brought up in the same environment are evidence for, and not against, the inheritance of mental traits. Those who would insist, as many do, that psychical characters are wholly the expression of the environment will find these contrasts very difficult to explain, but to their opponents who attribute the preponderating influence to heredity they present no difficulties, since the possibility of alternative inheritance has never been disputed. Among the other contents of the number is an article on primitive eugenics, by Mr. E. Torday, in which the eugenical value of the customs of certain central African tribes is pointed out and their good effects described.

The American Eugenics Record Office was founded in 1910, and is now well established in a career of useful activity. Among its latest publications is Prof. C. B. Davenport's "Trait Book" (Bulletin No. 6).

The main object of this work is to provide an indexed and classified list of mental and physical traits to assist, by enlarging their vocabularies, the "field-workers" employed by the office in the collection of data for the study of inheritance in man. A decimal system of classification is adopted. Simple numbers denote the primary classes and additional numbers are added to represent successive stages of subdivision; for example, 4 stands for mental traits, 45 special abilities, 459 special ability for athletics, 4595 for ball playing, and 45954 for golf. The classification does not appear to be always logical; thus after 46 is written "egoistic (temperament)," and after 4622 "optimism *vs.* pessimism," something different in kind to, and not a subvariety of, egoism. Not only field-workers, but others, even lexicographers, will find in this pamphlet additions to their vocabularies, but it is doubtful whether many will desire to use such words as "unanecdoteness" or "unconversationableness." Further, we would question the propriety of contrasting "ludicrousness" with "absence of sense of humour," as a sense of humour is the faculty which most effectively enables one to avoid being ludicrous. But though these and other criticisms might be made, the work is one of undoubted utility, and will no doubt be greatly improved in future editions.

E. H. J. S.

INFLUENCE OF GEOGRAPHICAL CONDITIONS UPON JAPANESE AGRICULTURE.

IN a paper read recently before the Royal Geographical Society, Miss E. C. Semple discussed, largely on the basis of personal observation, a number of interesting features in the influence of geographical conditions upon Japanese agriculture. Premising that islands, with climates rendered equable by marine influence, and with the further advantage of supplying "the double larder of land and sea," offer specially favourable conditions for the early development of civilisation, she showed that agriculture in such circumstances quickly becomes intensive owing to the demand of an expanding population upon a cultivable area which, being insular, is not capable of expansion. This condition is particularly marked in Japan, because to its insular character are added other contributing causes. Cultivation and settlement are rare above about 2300 ft. of elevation. Forests and barren highlands above this height clearly segregate the densely populated valley-settlements, which cling closely to the rivers and streams, where rice, the staple crop, may receive the necessary irrigation.

Moreover, it is not merely what may be termed the mechanical facilities for this cultivation which limit its distribution. The generally unfertile character of the soil has also to be taken into account. Miss Semple quoted the present percentage of arable land to the total area of Japan proper as only 14·37, and proceeded to show that so far as statistical data are available, only Finland, Sweden, and Norway show a smaller percentage, and these, unlike Japan, are sparsely populated countries. The reclamation of the unfertile and ill-watered wastes, and the diversification of crops, are beyond the means of the Japanese smallholder, though a few rich farmers or companies have undertaken such work.

In dealing with the fertilisation of the soil, Miss Semple adverted to "the practical absence of stock-raising." It has been sought to attribute this peculiar feature to the principles of the Buddhistic faith, but Miss Semple prefers to find its reason in the scarcity of natural pasturage or fodder-plants. She dealt at some length with the two classes of wet and dry fields characteristic of Japanese agriculture, together with the geographical effect of relief upon their distribution; on the other hand, she showed that the terrace system of cultivation usually associated with mountainous tracts alone is not so in Japan, because the irrigation of the lowland rice-fields also involves it. The raising of the silk-worm is found to be practically confined to inland provinces, and largely to upland farms, where communications are bad, and the natural tendency has been to develop a product of small bulk (and therefore easily conveyed) and high proportional value.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE Chemical Section may claim a fair share in what has proved to be a record year for the Association generally, and although the counter attractions of the International Congress had some effect on the attendance of the senior chemists, the section room was better filled than has sometimes been the case of late years. In particular Prof. Divers was greatly missed; for many years there has been no more regular supporter of the Association.

Whilst the plan adopted of grouping communications more or less under four main headings had the result that, as regards quality, the discussions were the best for some years past, this plan has the disadvantage that it tends to emphasise the very special nature of the subjects considered. The type of paper presented was satisfactory: brief summaries of the field rather than detailed accounts of method and results were the rule, and in consequence the task of the president in keeping to the time table was a light one.

The daily Press is apt to criticise the work of the section as too technical, but it must not be forgotten that the problems which chemists are now engaged in studying are essentially of a fundamental character. Dundee will perhaps be remembered as the "origin of life" meeting, and though the discussion on this subject was confined to the biologists, both in this discussion and in Prof. Schäfer's address it was admitted that chemical science must be looked to ultimately for light on the problems of life.

In acquiring accurate knowledge of the carbohydrates, fats and proteins, or of the properties of colloids, or in the study of enzymes and cell activators of all kinds, the chemist has already amassed a greater store of exact knowledge of biological import than is generally realised. Though he is forced at present by their very complexity to surround his conceptions in the technicalities of a nomenclature, which to the initiated is unique in its expressive simplicity, the day is not far distant when a more popular summary will be possible—indeed, only this year the announcement has been made of the success of nutrition experiments carried out entirely with synthetic food, every ingredient of which can be built up chemically from the elements.

The proceedings on Thursday, September 5, opened as customary with the presidential address, which has already appeared in full, the rest of the morning being devoted to physical papers. Prof. H. Marshall described the interaction between thiocarbamide, iodine and sulphur. Mr. A. J. Berry dealt with the distillation of binary mixtures of metals *in vacuo*, and described experiments showing that copper and cadmium are quantitatively separable by volatilisation of the cadmium, whereas magnesium and cadmium yield a non-homogeneous distillate. The compound $MgZn_2$ can be prepared by distilling alloys containing an excess of zinc beyond this composition; the excess of zinc volatilises.

Dr. C. H. Desch gave a brief summary of a very full report he has prepared on diffusion in solids, which was in print before the meeting. The final conclusion is that the occurrence of diffusion in metals is established beyond any doubt, but that experiments are still lacking to prove its occurrence in transparent crystals of minerals, salts, or organic substances. The report deals with diffusion in glass, the passage of gases through metals, and particularly with diffusion in solid metals, including cementation and decarburisation of iron. Dr. Holt followed with a paper on the sorption of hydrogen by palladium, in which he described his own recent experimental work.

The next paper, by Mr. R. de J. Fleming-Struthers, dealt with nitrogen chloride in relation to photochemical inhibition. When nitrogen chloride vapour, mixed with an indifferent gas, is heated, no change is perceptible until the temperature reaches a certain value; then suddenly decomposition begins and appears always to culminate in an explosion. Explosion likewise occurs in an atmosphere of hydrogen, but in this case an interaction sets in, and ammonium chloride is precipitated. When a similar mixture is exposed to the action of light, only very little of the nitrogen chloride is converted into ammonium chloride, showing that practically all the nitrogen chloride is decomposed by light before any hydrogen chloride can be formed. Nitrogen chloride is an inhibitor of combination between chlorine and hydrogen on exposure to light, and is capable of producing a period of inaction comparable to Bunsen and Roscoe's induction period.

Mr. A. Fleck gave an account of a careful chemical examination of Marckwald and Keetman's statement that thorium and uranium X could not be separated. This has been confirmed, the method chiefly used in the attempted separation being fractional precipitation. It was found impossible to alter the concentration of the short-lived radio-active element in thorium. Similarly radio-actinium and thorium, also thorium B and lead, were found to be two pairs of chemically inseparable elements.

A paper by Prof. Stock (Breslau) and Dr. G. E. Gibson on the dissociation of phosphorus vapour may be referred to here, though it was read on the Monday. The authors have determined the pressure temperature curves of phosphorus vapour at various volumes, using quartz apparatus and a new form of quartz membrane manometer devised by Gibson. Up to 700° C. the vapour density corresponds to the formula P_4. Above this, dissociation takes place according to the equation $P_4 = 2P_2$.

On the Friday the section joined with the botanists to discuss questions of chemical variation in plants and the nature of plant pigmentation.

Dr. J. V. Eyre gave an account of work carried out with Prof. H. E. Armstrong on the enzymes and glucoside of flax. The glucoside linamarin is constantly present in the green plant and in the unripe seed of flax; in consequence, hydrogen cyanide can usually be detected in commercial linseed cake. Ripe seeds are free from cyanide, but since flax flowers during a considerable period, the seeds are never ripe all at once. In extreme cases the amount of hydrogen cyanide may be sufficient to be harmful, but it is also probable that it is of positive condimental value, and that the special value of linseed cake as a cattle food may be due in part to the liberation of minute proportions of hydrogen cyanide.

In addition to common flax, a wide variety of Linaceæ have been tested; only the white, blue, or red-flowered varieties contain the glucoside, which is entirely absent in all the yellow flowering species examined. Dr. Eyre also gave an account of the variations in the flax plant with locality, flax being a plant which rapidly becomes adapted to new conditions. Seed taken from a blue flowering crop is commonly stated to give a crop of flax bearing white flowers when raised under different conditions of climate. A number of similar instances of degeneration were noted. In the discussion Prof. Bateson expressed the opinion that it should not be difficult to select a type of flax which would breed true for any desired qualities. Probably the commercial seed was impure, so that under changed conditions a previously minor constituent of the mixture was unduly favoured. This would account for much of the variation mentioned.

Prof. Armstrong gave an account of the variation of glucoside and enzyme in *Lotus corniculatus*, which has been studied over a wide area. The glucoside of this plant contains hydrogen cyanide, and is probably identical with that present in flax. Whereas in 1910 plants collected near Reading contained the glucoside, it was, as a rule, missing from plants gathered in other localities. During 1911 cyanide was found uniformly present in plants from different parts of England, but it was frequently absent in specimens from the west of Scotland and from Norway. Variation in the age or habit of the plant or in the nature of the soil had no effect on the presence of cyanide. The glucoside was always accompanied by the appropriate enzyme, whereas in the allied species *L. major* neither enzyme nor glucoside ever occur. This paper was very fully discussed by Prof. Bateson and the botanists present, and it was regarded as a significant case of chemical variation in plants which requires further study.

A joint paper on the biochemistry of plant pigmentation by Prof. F. Keeble and Dr. E. F. Armstrong was read by the latter, who gave a general summary of the subject from the chemical side, supplementing that contained in the presidential address to the botanists. It is probable that the soluble sap pigments of plants are formed by the action of an oxydase on a colourless chromogen, which has first to be liberated by the appropriate enzyme from its combination with glucose. It is possible that amino-acids or other protein degradation products take part in the interaction, and that this variable factor accounts for the differences in shade. Methods were described which enable the exact localisation of the oxydases in plant tissues, either macro- or micro-chemically, without any far-reaching breakdown of the cellular structure taking place. It has been possible to show in the clearest manner possible that the localisation of these oxydases in plants agrees closely with that of the colour.

Oxydases, according to current theory, are supposed to consist of two constituents—a peroxydase and an organic peroxide. Normally the occurrence of the latter is rare, but the authors produced evidence to show that it increases in amount when a plant is kept in the dark. After such treatment it can be detected in plants from which it was formerly absent. The amount of peroxydase is also increased during the night. These observations give a clue to some of the phenomena of periodicity in life.

Attention was also directed to the chemical identification and study of the inhibiting factors in plants and animals to which Mendelians attach so much importance.

Besides the oxydases measured by the authors' methods, evidence is obtained that others are present in plants which may or may not be different. Such become prominent when the plant is wounded or treated with chloroform, with the result that browning or blackening takes place. Evidence is being accumulated as to the nature of oxydases, more particularly whether they are to be regarded as enzymes.

A further contribution from the Reading laboratory by Mr. W. N. Jones dealt with the distribution of oxydases in white flowers. Many white flowers contain a chromogen which becomes coloured (brown) when acted upon by an oxydase or peroxydase. The author considers that this chromogen is probably not identical with that responsible for the colour in the flower of coloured varieties of the same species. The chromogen may be associated with oxydase or with peroxydase only, or it may be altogether lacking from the flower. It is possible to extract this chromogen after destroying the oxydase by boiling, and use the solution as a test for oxydase in the same way as benzidine.

A paper by Mr. A. Compton gave a summary of Prof. Bertrand's investigation of the action of enzymes on the complex glucoside vicianin, a constituent of *Vicia angustifolia*, a rare species of tare.

On Monday, September 9, the section divided, the physical chemists taking part in a joint discussion with Section A, opened by Dr. F. A. Lindemann, with a paper on the atomic heat of solids. This is reported more appropriately in the proceedings of Section A. The organic chemists devoted the morning entirely to the subject of carbohydrates. It is a remarkable fact that in spite of the great importance of the sugars as foodstuffs and the part they play in plant and animal economy, our knowledge of them is still of the scantiest. The complexity of the sugar molecule and the experimental difficulties which beset the worker in this field render progress but slow, and any researches, even if they be of the type classed by scoffers as compound making, will be of the utmost value if they serve in any way to indicate new methods of attacking the subject or lead to greater certainty of the knowledge of chemical structure. The problems of the sugars are certainly quite as complex as those of the proteins; their solution must be accomplished before any real attack is made on the origin of life.

Three communications were received from the St. Andrews laboratory. The first, by Prof. Irvine and Mr. A. Hynd, dealt with synthetic aminoglucosides. Aminoglucose, or glucosamine, as it is usually called, constitutes the simple unit which, when polymerised, forms chitin, the horny constituent of the shell of the lobster, and which occurs in place of cellulose in the cell walls of many of the lowly organisms. Hitherto the properties of glucosamine have been but little investigated. Some of the experimental difficulties have been overcome now by the use of bromotriacetylglucosamine, which enters into reaction with widely different types of hydroxy compounds. The 2-aminoglucosides thus obtained correspond with amino derivatives of the natural glucosides, which exist in such diversity in plants. Many of the synthetic substances are not simple amino compounds, but their nitrogen atom is associated with the contiguous oxygen atom to form a four-membered betaine ring; they are thus brought into relation with the betaines of plants. Others, again, particularly those in which a benzene grouping is present, do not show this peculiarity of ring formation. This paper gave rise to a full discussion.

In the following paper, by Prof. Irvine and Miss B. M. Patterson, an account was given of the experimental study of the constitution of mannitol triacetone. It is impossible to arrest the condensation of mannitol with acetone at intermediate stages, but by carefully regulated hydrolysis the acetone molecules can be removed in stages. The constitution of the intermediate compounds was determined by methylation and subsequent hydrolysis. The acetone residue is shown to be attached through oxygen to two contiguous carbon atoms, but the order in which the acetone residues were removed was quite unexpected. It is impossible to discuss the problem without entering into complex stereochemical considerations, but as a result of the work and the methods used in it, a deeper insight has been gained into the sugar molecule than had previously been the case.

The third paper, by Prof. Irvine and Dr. J. P. Scott, dealt with the rotatory powers of partially methylated glucoses. By applying stereochemical considerations based on the optical rotatory power of the isomeric glucoses and glucosides, configuration formulæ for the α and β isomerides have been deduced which are in agreement with those previously suggested by E. F. Armstrong. Certain regularities in the rotatory power of the α and β forms of the partially methylated glucoses were pointed out: these conform to the rule postulated by Hudson.

Dr. W. S. Mills described a simple method of preparing acetyliodoglucose, a compound which has in the meantime been prepared by Fischer in another way. By the action of copper hydride on this, a crystalline compound has been obtained which is considered to be the acetyl derivative of a diglucose, in which, however, the two molecules are united through carbon, and not through oxygen as in the natural sugars.

Dr. Harden followed with a summary of the knowledge of hexose phosphate, which, as his researches have shown, plays so important a part in the phenomenon of alcoholic fermentation. Dr. Harden discussed the equations which have been suggested to explain the action of the phosphate during fermentation: he was inclined to accept that which involves the rupture of glucose into two three-carbon compounds, one of which is further broken down into carbon dioxide and alcohol, whilst the other unites with a similar compound from a second molecule of sugar to form hexose phosphate.

The sitting concluded with a paper on nomenclature by Dr. E. F. Armstrong. It is suggested to number the six carbon atoms in glucose thus:—

$$\overset{6}{C}H_2OH.\overset{5}{C}H(OH).\overset{4}{C}H(OH).\overset{3}{C}H(OH).\overset{2}{C}H(OH).\overset{1}{C}HO,$$

instead of using Greek letters as at present. This avoids the confusion arising from the common use of α and β to indicate isomerism in the groups attached to the asymmetric carbon atom in position 1. Prof. Irvine concurred in this suggestion. Attention was also directed to the uncertainty introduced in the nomenclature of optically active compounds by using the prefixes *d* and *l*, sometimes to denote the sense of the rotation and sometimes to denote the relationship in configuration to *d*-glucose.

The greater part of Tuesday's proceedings were devoted to papers dealing with subjects of importance to organic chemists—namely, the migration of groups and the laws of substitution in the benzene ring.

The methods by which chemists are wont to determine the structure of a compound and the precise position in it of certain groups all depend on the displacement of this group by another at some stage of the investigation. It is important to know that such substitution takes place in a simple manner, and that the new group is not introduced in some altogether different position. Unfortunately for our theories, it was found by Walden some few years back that in the case of optically active compounds such rearrangement is the rule rather than the exception. In consequence, when some new compound is obtained from an optically active substance, it is frequently impossible to say whether the substance formed is the desired compound or its mirror image. The mechanism of such interactions has been fully studied by E. Fischer in Berlin and A. McKenzie in London, and it was appropriate that the latter should give a concise though clear and logical summary of the question, which is generally spoken of as the Walden rearrangement, before the section. A considerable discussion ensued.

Dr. Lowry followed with a paper dealing with a closely allied subject, that of isomeric change, and more especially with those taking place in solutions of the crystalline amide and piperidide of camphorcarboxylic acid. This case is of exceptional complexity, since the experimental measurements show that three distinct isomeric changes take place, and that a condition of equilibrium is established ultimately between four distinct isomerides. The equations for consecutive unimolecular changes of this type were described at length, as well as the curves representing change, and they were afterwards discussed by Prof. Soddy and others.

The second part of Dr. Lowry's communication dealt with the use of certain models to explain Barlow and Pope's theory of molecular structure based on valency conceptions. A very fluent account was given of a difficult subject, which was closely followed by those present.

The next two papers, by Prof. K. J. P. Orton, of Bangor, and Prof. Holleman transferred attention to the laws of substitution in the benzene series. Prof. Holleman's status in this field is well known, and the section was fortunate in having his cooperation throughout the meeting. Prof. Orton dealt with the conversion of chloro-, bromo-, and nitro-aminobenzenes into the carbon substituted anilines and anilides, giving a detailed account of his recent work. Prof. Holleman described work carried out in conjunction with Mr. J. P. Wibaut on the nitration of the chlorotoluenes. He indicated the number of isomerides formed in the various cases, and showed both how to calculate approximately their proportions and how well these figures agreed with those determined experimentally by the laborious separation of the constituents of the mixture.

A brief communication by Dr. J. K. Wood, who acted as local secretary for the section, was of considerable interest. Leucine and similar amphoteric substances are in reality internal salts, the acidic and basic groups neutralising each other. When an acid or base is added, the internal salt is broken up and a true salt formed with the added acid or base. In the case of an optically active substance it should be possible to determine the rotation when the whole of the internal salt has just been broken up, and so calculate the acidic and basic constants of the amphoteric substance. Leucine is lævorotatory in aqueous solution, but on the addition of hydrochloric acid the solution becomes increasingly dextrorotatory. When about 1·34 equivalents of acid have been added, the effect of further addition is much smaller, and there is a sharp bend of the curve at this point corresponding with the complete disappearance of the internal salt.

Equally sharp results could not be obtained with sodium hydroxide, owing to racemisation being caused by the alkali.

The method can be used at all events qualitatively to measure the strength of the added acids; the weaker the acid the more concentrated it must be to break up the internal salt. By working with a common acid, various amphoteric substances may be compared.

Owing to the shortness of time, Prof. C. R. Marshall gave a very brief account of the two papers standing in his name. The action of bromine on strychnine has been investigated with the object of preparing a dibromo compound as described by some authors, but this does not appear to exist. The second paper dealt with pentaerythritol tetranitrate.

The final communication on phototropy was delivered by the president, who showed specimens of phototropic compounds obtained in the course of investigations on salicylidene amines. Of a large number of such compounds examined, fourteen have been found to exhibit phototropy distinctly—that is, they change in colour on exposure to light. In studying the influence of temperature on the phenomenon, it has been found that while some are phototropic at temperatures up to their melting points, others have a limiting temperature, above which they are not phototropic, whilst in two cases compounds which are not phototropic at the ordinary temperature show this property below zero centigrade.

The explanation of phototropy is still outstanding; it has been considered in turn as due to intramolecular rearrangement, stereoisomerism and polymorphism. Another problem is the nature of the energy evolved when the darker-coloured phototrope in the absence of solar energy, or possibly also when under solar influence, returns to the lighter form: this remains for future investigation.

A novel and successful feature of the meeting on its less severe side was the sectional supper held on the Saturday.

E. F. A.

THE DIFFUSION OF EDUCATION AND KNOWLEDGE.[1]

THE educational status of a nation consists in the amount of literacy, number of teachers, and number of persons in its primary and secondary schools, and in its colleges and universities, relative to population. The status of knowledge may be indicated by the number of books, periodicals, and newspapers relative to population. This knowledge may take two forms, one gained through books, the other through periodicals and newspapers. One is knowledge in general; the other consists more in current information.

The question may be asked, if a community or country leads another in literacy, diffusion of education and knowledge; if, relative to its population, it has more pupils in school, more teachers, more students in colleges and universities, more books in its libraries to read, and more periodicals and newspapers to peruse, is not this country or community, as a whole, very probably better educated and more intelligent than the other country or community? While there are exceptions due to special conditions, we are disposed to answer this question in the affirmative.

Table I. indicates in a general way the diffusion of education and knowledge in some leading countries.

Column 1 gives the relative amount of illiteracy among army and navy recruits. As these are mostly adults, they probably represent best the real amount of illiteracy. Column 6 gives the number of publications (relative to population) in the list of the Smithsonian Institution in Washington. These publications are of the highest class, including journals issued by learned societies and governmental institutions.

Examining Table I., it will be seen that Switzerland is much in advance of all the other countries in general diffusion of education and knowledge, and

[1] From a paper on "Mentality of Nations in Connection with Patho-Social Conditions," by Arthur Macdonald, in *The Open Court* for August.

Russia is last. Italy also is very low in these respects. France shows a high degree (next to Switzerland) of diffusion in university education (81) and newspaper information (251). Germany shows the lowest degree of illiteracy and publishes the largest number of books, but not relative to its population. Denmark issues the largest number of books relative to population.

The United States, compared with European nations, is next to highest (Switzerland) in number of newspapers issued, but next to lowest (Russia) in number of university students enrolled and books produced, relative to population.

Since we are disposed often to estimate countries as to their mental status or literary production without reference to their population, we will compare the countries in Table I. according to the absolute number of books, periodicals, and newspapers published, as given in columns 7, 8, and 9.

Denmark, which is behind France, Great Britain, and the Netherlands. There is no further correspondence of these three highly literate countries in the other educational columns.

In brief, there appears to be but little necessary relation in these countries between degrees of education and amount of literary production. Thus, Italy, with its great illiteracy, stands very high in university education. This is interesting in connection with the fact that Italy is doing some of the best work in sociology, which is suggestive in connection with the further fact that she stands next to the highest in production of sociological works.

The United States has a large percentage of illiteracy, yet ranks highest in percentage of population enrolled in schools, but has the smallest number of university students. It has next to the largest number of newspapers, but produces next to the smallest number of books. Russia, about which data are more difficult to obtain, stands lowest in all respects relative to its population.

TABLE I.

Country 1908	Education				Knowledge and information				
	Number of illiterates per 10,000 recruits	Per cent. of population enrolled in schools	Number of university students per 10,000 population	Number of newspapers per million population	Number of books published per 100,000 population	Smithsonian list: Number of publications per million population (1904)	Number of books published	Number of newspapers and periodicals issued (year)	Smithsonian list: Number of publications (1904)
Column	1	2	3	4	5	6	7	8	9
Belgium	833[1]	12·2	68	27	28	48	2763	209 (1908)	354
Denmark	20[2]	13·0		84	135	42	3519	220 (1908)	112
France	346[1]	14·2	81	251	28	42	8799	9877 (1908)	1723
Germany...	4[1]	17·0	65	115	49	39	33317	7000 (1907)	2390
Great Britain and Ireland	100[1]	17·0	56	98	22	45	9821	4400 (1905)	2038
Italy	3072[3]	8·1	77	60	21	24	6918	2067 (1904)	834
Netherlands	210	15·0	72	132	56	36	3258	760 (1906)	207
Russia	6110[4]	4·5[5]	16	8	—	3	23852	2220 (1905)	515
Switzerland	9	18·6	178	275	116	90	4256	1005 (1907)	551
United States...	380[6]	19·7	20	260	10	—	9254	21320 (1908)	—

[1] 1904. [2] 1897. [3] 1903. [4] 1895. [5] 1907: in 1907, 39 per cent. of males and 27 per cent. of all persons (9 years of age and more) were able to read. [6] In white male population 21 to 24 years of age in 1900.

As to largest number of books the rank is Germany, Russia, Great Britain, United States, France, Italy, Switzerland, &c.

As to number of newspapers and periodicals, United States is unique, publishing twice as many as France (next in rank), and from three to ten times as many as some of the other countries.

As to the Smithsonian list of publications, the rank is Germany, Great Britain, France, Italy, Russia, Belgium, Switzerland, &c.

If we take the extremely illiterate countries, as Russia, Italy, and Belgium, we find a correspondingly low percentage of the population enrolled in the public schools and a relatively low percentage of newspapers published. But when we come to the number of university students enrolled, the correspondence fails as to Italy and Belgium, which have, relative to population, a larger number of university students than Germany or Great Britain. As to the number of books published relative to population, the correspondence fails in the case of Belgium, which produces as many books as France (column 5), relative to its population. As to the Smithsonian list of publications, the correspondence fails in the case of Belgium, which is next to the highest (column 6).

If, now, the countries distinctly the least illiterate, as Germany, Switzerland, and Denmark, are compared in respect to enrolment in schools or primary education, the correspondence fails in the case of

Different countries naturally do not classify books in the same way, and sometimes one country will include under one head publications that other nations would place under another subject, and hence results given in Table II. must be taken in a general way.

In order to render the table more trustworthy, we have included two or more subjects under one head. For instance, under "History," both "Biography" and "Geography"; under "Literature," "Poetry," "Fiction," and "Drama," and under "Religion," "Theology." "Fiction" is both put by itself and also combined with "Literature."

A few headings could not be classified nor combined with others and were omitted, so that the table is not complete, but the percentage for each subject given is, of course, not affected.

It may be interesting to note the kind of books some countries prefer, as shown in Table II. Thus, France publishes relatively more medical works (10·5) than any other nation here mentioned. Italy is second (7·6) and Germany third (5·8) in this subject. Belgium publishes relatively the most law books, Denmark the fewest. United States, Denmark, and Germany lead in religious works. Denmark and France excel in literature, and Germany and Italy in educational works, and France in books on military science.

TABLE II.—*Book Production—Per Cent. for Each Subject.*

Country 1908	Medicine	Law	Philosophy	Religion	History	Sociology	Literature	Education	Art	Science	Military science	Fiction
Belgium	5·7	7·0	2·6	3·8	13·4	8·6	17·3	3·8	6·2	7·0	1·1	—
Denmark ...	3·7	1·1	1·2	9·6	—	—	23·2	3·3	2·2	9·7	—	—
France	10·5	6·3	2·1	7·3	17·3	6·4	22·0	11·4	1·2	4·5	3·9	—
Germany... ...	5·8	10·0[1]	2·3	8·4	9·0	10·0[1]	19·5	13·8	2·9	5·7	2·3	13·7[4]
United Kingdom	3·1	2·6	—	9·5[2]	13·9	6·7	18·4	6·4	—	11·8	—	2·6
Italy	7·6	4·9	2·8	4·4	12·0	6·7	14·1	13·1	2·6	5·8[3]	1·9	6·3
Netherlands ...	3·3	5·3	—	6·2	—	5·3	—	9·3	—	5·3[3]	—	—
Russia	4·6	3·1	—	6·8	3·0	—	10·2	7·9	—	2·5	—	—
United States...	3·6	9·9	1·9	8·8	14·7	5·9	13·3	4·5	2·5	5·1	—	16·0

[1] Law and political science. [2] Religion and philosophy. [3] Science and technology. [4] Belles lettres.

Although correspondence between mental and pathosocial conditions, or concomitant relations, does not necessarily indicate causal connection, yet it is interesting to note a few instances. In general, those countries which have the greatest illiteracy, as Italy, Belgium, and France, show the highest percentage of murder. They also have a high percentage of stillbirths, death-rate, and death-rate under one year of age. Two of these countries, where the illiteracy is more pronounced, as in Italy and Belgium, show a low rate of suicide and divorce. On the other hand, the least illiterate countries, as Germany, Switzerland, and Denmark, have a high rate of suicides.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The chair of midwifery recently vacated by Dr. Edward Malins has been filled by the appointment thereto of Dr. Thomas Wilson, who has previously held the post of lecturer in this subject.

CAMBRIDGE.—Prof. R. C. Punnett has been selected by the Prime Minister and Mr. A. J. Balfour as the first Arthur Balfour professor of genetics.

A prize of 50*l.* out of the Gordon Wigan Fund will be awarded at the end of the Easter term, 1913, for a research in chemistry, of sufficient merit, carried out in the University of Cambridge. The research may be in any branch of chemistry. The dissertation, with the details of the research, must be sent to the professor of chemistry not later than June 13, 1913.

The current number of *The Reporter* contains revised schedules of the special examination in geography for the ordinary degree, and for the examination for the diploma in geography. It also contains the list of subjects for the special examination in military subjects for next year.

OXFORD.—On November 19 Convocation will be asked to assent to a decree providing that a plot of land on the south side of the University Park, and another plot at the north-west angle of the park, be assigned for the purposes respectively of a chemical and an engineering laboratory. It is possible that the proposals will meet with opposition, as many members of the University are averse from further encroachments on the space available for recreation. At a later date statutes will be submitted to Congregation amending the present constitution (1) of the Hebdomadal Council by abolishing the existing division into "Orders" of its elected members, and (2) of Congregation, by abolishing the present qualification of residence, and enacting that in future Congregation shall consist of the teaching and administrative elements in the University and colleges. Another proposed statute provides, in certain circumstances, for a poll of Convocation to be kept open for three days. It is thought that the second at least of these proposals, *i.e.* that relating to Congregation, will be resisted.

The election to a fellowship at All Souls' College of a graduate distinguished in mathematics or natural science is a rare occurrence, hence it is specially worthy of record that Mr. D. B. Somervell, of Magdalen College, one of the latest elected fellows of All Souls', obtained honours in mathematical moderations in 1908, and first-class honours in chemistry in 1911.

The new Pharmacological Laboratory was formally opened on November 9 in the presence of the Vice-Chancellor and a large assemblage of Oxford medical graduates. The history of the department was briefly recounted by Sir William Osler, Regius professor of medicine, and an address on "The New Pharmacology" was delivered by the Reader, Dr. J. A. Gunn. Space for the new laboratory has been found by the insertion of a floor in the rooms on the west front of the museum formerly occupied by the Radcliffe Library. Of the two stories thus formed, the upper is devoted to pharmacology, the lower is shared between the Hope department of entomology and the department of mineralogy.

LIEUT.-COL. W. W. O. BEVERIDGE, D.S.O., Royal Army Medical Corps, has been appointed professor of hygiene at the Royal Army Medical College, Grosvenor Road, S.W., in succession to Brevet-Col. C. H. Melville.

WE learn from *Science* that Mr. T. W. Todd, at present lecturer in anatomy at Victoria University of Manchester, has been appointed Henry Willson Payne professor of anatomy in the medical department of Western Reserve University in the United States. Prof. Todd will take up his new duties in December.

THE sum of 10,000*l.*, free of Government duties, has been bequeathed by the late Misses Mary, Hannah, and Helen Dalgety and Mrs. Isabella Dalgety, or Wilson, to the University of Edinburgh for the foundation and endowment of bursaries not exceeding 50*l.* for two years and prizes in the law faculty of the University.

A MEETING of the governors of the South-Eastern Agricultural College, Wye, was held under the chairmanship of Lord Ashcombe, at Caxton House, on Monday, November 11. The governors considered the proposed establishment of a fruit research plantation in the south-eastern district, and decided to accept the responsibility of administering such a plantation with the aid of the grant of 500*l.* offered by the Board of Agriculture.

THE council of the City and Guilds of London Institute has conferred the fellowship of the institute upon Mr. A. Chatterton and Mr. W. D. B. Duddell, F.R.S. This distinction is extended to those students who have obtained the associateship of the institute, and spent at least five years in actual practice, and by original and valuable research work or otherwise have contributed to the advancement of the industry in which they are engaged.

RECENTLY the faculty of medicine of the University of Giessin conferred the honorary degree of doctor of medicine upon Ernst Leitz, Junior, the junior partner of the celebrated optical firm, E. Leitz, of Wetzlar, and 18 Bloomsbury Square, London. It is only a little more than a year since the University of Marburg honoured the senior partner of the same firm by conferring upon him the degree of doctor of philosophy. It must be gratifying to the firm that its services towards science are so highly appreciated and recognised.

A JOINT conference on the Montessori system of education, arranged by the Child Study Society (London) and the Montessori Society of the United Kingdom, will be held at the Royal Sanitary Institute, Buckingham Palace Road, S.W., on Saturday, November 16. The chair will be taken at 3 p.m. by the Hon. Sir John A. Cockburn, K.C.M.G. The conference will be preceded on Friday, November 15, at 7.30 p.m., by a lecture by Madame Pujol-Segalas (of Paris) on "Maria Montessori's Method and Self-education." Mr. R. Blair, education officer of the London County Council, will preside.

THE following lectures for advanced students of the University and others interested in the subjects are announced in *The London University Gazette*. A course of six lectures on "Methods of Illumination as applied to Microscopy," at Charing Cross Hospital Medical School, Chandos Street, W.C., by Mr. J. E. Barnard, at 5 p.m. on Thursdays, beginning on November 14; and a course of three lectures, on "Recent Work in Experimental Embryology," in the Zoological Lecture Room of University College, by Dr. J. W. Jenkinson, on Fridays, November 29, December 6 and 13, 1912, at 5 p.m. Admission to the lectures is free, without ticket.

MR. A. G. WARREN has been appointed a lecturer in the engineering faculty of the University of Hong Kong. He was a lecturer in the East London College, and has been head of the engineering department of the Aston Manor Technical School, Birmingham, for the last eighteen months. In July last Prof. C. A. M. Smith (of the East London College) was appointed to the Tai Koo chair of engineering in that University, and immediately proceeded to the Far East to take up his new duties. The Hong Kong University opened its doors to students in October, 1912, and, although the equipment of the engineering department had not then been commenced, there were thirty-five engineering students who passed the entrance examination, and who now form the first-year engineers of the latest British university. It is interesting to record the fact that these Chinese engineering students have come from many different parts, and include some from Straits Settlements, Canton, and Foochow.

VARIOUS changes are proposed in the regulations for the examinations for certain junior appointments in the Civil Service. The age limits for the appointments being eighteen to nineteen and a half years, they are as a rule competed for by candidates from secondary schools. Certain subjects in the examination are compulsory; while the optional subjects are divided into two classes, the papers in one being of a lower standard than those in the other, and consequently receiving only half the marks of the higher papers. At present, papers of lower standard are set in mathematics, French, German, Latin, Greek, English history, chemistry, and physics; and higher papers are set in mathematics, French, German, Latin, Greek, English and European history, chemistry, and physics. It is proposed in 1914 to set a lower paper in European history in addition to the subjects named above, and no longer to set higher papers in history, chemistry, and physics. It is clear that the proposed change will operate unfavourably against schools where two classical languages are not taught, and against candidates whose abilities are scientific rather than linguistic. We are glad to notice that the Education Committee of the London County Council has passed a resolution to this effect, which is being sent to the Civil Service Commissioners for their consideration.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Anthropological Institute, November 12.—Dr. A. P. Maudslay, president, in the chair.—R. W. **Williamson**: The Mekeo people of New Guinea. Mr. Williamson gave an account of the Mekeo modes of courtship and ceremony of marriage. For the former, love charms and philtres are extensively used, and the rising sun is appealed to for help. The negotiations for the marriage involve substantial gifts by the boy's family to that of the girl, including ornaments, &c., which are presented at the time of the negotiations, and pigs, which the girl's relatives afterwards secure by means of a mock hostile raid upon the boy's clan. The author also described some of their ceremonial dances, which he believed to have an origin in an imitation of the dancing movements during the courting season of the goura pigeon, and elaborate ceremonial performances, at which much coveted decorations are bestowed upon warriors who have slain an enemy in battle; also their funeral and mourning ceremonies, the former of which includes a comic feast and a game of "bob-apple"—the apple being the leg of a pig or kangaroo.

PARIS.

Academy of Sciences, November 4. M. Lippmann in the chair.—G. **Bigourdan**: The International Time Conference. The first meeting was held at Paris on October 15, and was attended by the representatives of fifteen Governments. The work was subdivided amongst four subcommittees, and a detailed account is given of their conclusions and suggestions.—Paul **Appell**: The theorem of the last Jacobi multiplier connected with the formula of Ostrogradsky or Green.—L. **Maquenne** and E. **Demoussy**: The determination of respiratory coefficients. A discussion of the relations between the apparent and true respiratory coefficients when determined in a fixed volume of air.—W. **Kilian** and Ch. **Pussenot**: The age of the shining schists of the Franco-Italian Alps. There is a break in these strata, a portion being Mesozoic and another part Tertiary. These two portions are probably stratigraphically discordant.—Kr. **Birkeland**: The origin of planets and their satellites. From experimental considerations the author has been led to the view that in solar systems in course of evolution there exist forces of electromagnetic origin of the same order of magnitude as that of gravitation. The retrograde revolution of the recently discovered moons of Jupiter and Saturn is in accordance with this view.—MM. **Fayet** and **Schaumasse**: The elliptic elements of the 1912*b* comet (Schaumasse comet): its identity with the Tuttle comet.—P. **Idrac**: Spectroscopic observations of the Gale comet (1912) made at the Meudon Observatory. The photographs showed the usual comet spectrum, with hydrocarbon and cyanogen lines.—M. **Borrelly**: The discovery and observation of the comet 1912*c*, made at the Observatory of Marseilles. The comet is of 9·5 magnitude, 2′ in extent, round, with a nucleus and without a tail. Its positions are given for two observations on November 2.—Michel **Plancherel**: The problems of Cantor and of Dubois-Reymond in the Legendre theory of series of polynomials.—G. **Ribaud**: The spectrum of magnetic rotation of bromine. The Righi effect has been studied with more powerful magnetic fields, up to 24,000 Gauss. The re-establishment of the light observed longitudinally in the magnetic field cannot be attributed to a Zeeman effect; all the absorption lines of bromine show the phenomenon of magnetic rotatory polarisation, on condition that for any given line a suitable vapour pressure is chosen. The appearance of the magnetic rotatory spectrum changes completely when the pressure is altered.—Léon and Eugène **Bloch**: The ionisation of gases by the Schumann rays. Ordinary sources of ultra-violet light placed in air emit a considerable proportion of rays sufficiently refrangible to be partially absorbed by quartz, and brass is very sensitive to the photoelectric effect of these rays.—Georges **Meslin**: Thermoelectric couples.—A. **Leduc**: A new method for determining the ratio of the two specific heats of a gas. This is a modification of the Laplace method, and has the advantage of requiring no other instrument than a good balance and thermometer. A large globe of not less than three litres capacity is filled with the gas at 0° C., and accurately weighed. It is then placed in a bath at a known temperature, the tap momentarily opened, and the mass of gas remaining in the globe determined by weighing. The theory and limits of accuracy of the method are worked out in the paper.—Henri **Stassano**: The opposed actions of the magnetic field on the electrical conductivity of rarefied gases as a function of the value of the field and the degree of vacuum.—M. **Lelarge**: A cause of explosion of tubes containing a compressed mixture of air and hydrogen. While measuring the pressure and density of some compressed hydrogen, an explosion occurred in which two workmen were killed. The author has investigated the conditions under which such an explosion may take place, and draws some practical conclusions from his experiments with a view to avoid such explosions in future.—J. **Couyat**: A meteorite from Hedjaz, Arabia. A full chemical and mineralogical analysis of the meteorite is given.—Paul **Vuillemin**: Periodic variation in specific characters. Studies of the flowers of *Phlox subulata*. A. **Petit**: The non-fixation of phosphoric acid by an acid forest soil.—L. **Lindet**: The conditions of combination of calcium and phosphorus in the casein of milk. About one-half of the phosphorus contained in casein precipitated from milk by rennet is in the condition of calcium phosphate, but the other half is in organic combination as a phosphate. Only three-fifths of the calcium is combined with phosphoric acid, the remainder saturating the free acidity of the casein.—Marcel **Mirande**: The existence of cyanogenetic principles in *Centaurea crocodylium* and *Tinantia fugax*.—A. **Desmoulière**: The antigen in the Wassermann reaction. A new method of preparation of the antigen is given possessing greater delicacy than the original Wassermann preparation.—Louis **Boutan**: Observations relating to the vocal manifestations of an anthropoid ape, *Hylobates leucogenys*. The sounds emitted by this ape are classified. They differ from a language, properly so-called, in that they are not produced by education, and hence represent nothing conventional, and are simply spontaneous sounds.

BOOKS RECEIVED.

The Botany of Iceland. Edited by Dr. L. K. Rosenvinge and Dr. E. Warming. Part i., The Marine Algal Vegetation. By Dr. H. Jónsson. Pp. vi+186. (Copenhagen: J. Frimodt; London: J. Wheldon and Co.)

Handwörterbuch der Naturwissenschaften. Edited by E. Korschelt and others. Lief. 19–22. (Jena: G. Fischer). Each 2.50 marks.

The Cochin Tribes and Castes. By L. K. A. Krishna Iyer. Vol. ii. Pp. xxiii+504. (Madras: Higginbotham and Co.; London: Luzac and Co.)

Through Shên-Kan. The Account of the Clark Expedition in North China, 1908–9. By R. S. Clark and A. de C. Sowerby. Edited by Major C. H. Chepmell. Pp. iii+247. (London: T. Fisher Unwin.) 25*s*. net.

The Origin of Civilisation and the Primitive Condition of Man. By the Right Hon. Lord Avebury. Seventh edition. Pp. xxviii+454. (London: Longmans and Co.) 7*s*. 6*d*. net.

The "Newest" Navigation Altitude and Azimuth Tables. By Lieut. R. de Aquino. Second edition. Pp. xlix+176+New Altitude Tables pp. v*+36*. (London: J. D. Potter.) 10*s*. 6*d*. net.

Lehrbuch der Grundwasser- und Quellenkunde. By K. Keilhack. Pp. xi+545. (Berlin: Gebrüder Borntraeger.) 20 marks.

Matematica Dilettevole e Curiosa. By I. Ghersi. Pp. viii+730. (Milano: U. Hoepli.) 9.50 lire.

Trattato di Chimico-Fisica. By Prof. H. C. Jones. Translated by Dr. M. Giua. Pp. xx+611. (Milano: U. Hoepli.) 12 lire.

Geology of New Zealand. By Prof. P. Marshall. Pp. viii+218+map. (Wellington: J. Mackay.)

The Spiritual Interpretation of Nature. By Prof. J. Y. Simpson. Pp. xv+383. (London: Hodder and Stoughton.) 6*s*. net.

The Feet of the Furtive. By C. G. D. Roberts. Pp. 277. (London: Ward, Lock and Co., Ltd.) 6*s*.

Michigan Bird Life. By Prof. W. B. Barrows. Pp. xiv+822+70 plates. (East Lansing, Mich.: Michigan Agricultural College.)

The Childhood of Animals. By Dr. P. C. Mitchell. Pp. xiv+269. (London: W. Heinemann.) 10*s*. net.

Herpetologia Europæa. By Dr. E. Schreiber. Zweite Auflage. Pp. x+960. (Jena: G. Fischer.) 30 marks.

General Report on the Operations of the Survey of India during the Survey Year 1910–11. Prepared under the direction of Col. S. G. Burrard. Pp. vi+29+12 plates. (Calcutta: Surveyor-General of India.)

Fatty Foods: their Practical Examination. By E. R. Bolton and C. Revis. Pp. x+371. (London: J. and A. Churchill.) 10*s*. 6*d*. net.

Key to Hall's School Algebra. Part i. By L. W. Grenville. Pp. 317. (London: Macmillan and Co., Ltd.) 6*s*.

Die Mutationen in der Erblichkeitslehre. By Prof. H. de Vries. Pp. 42. (Berlin: Gebrüder Borntraeger.) 1.60 marks.

Sleeping Sickness. By Dr. F. M. Sandwith. Pp. v+56. (London: Macmillan and Co., Ltd.) 4*d*.

Questions of the Day in Philosophy and Psychology. By Dr. H. L. Stewart. Pp. x+284. (London: E. Arnold.) 10*s*. 6*d*. net.

Les Aciers au Nickel et leurs Applications à l'Horlogerie. By C. E. Guillaume. Pp. 54. (Paris: Gauthier-Villars.) 2 francs.

Canada Department of Mines. Mines Branch. Report on the Utilization of Peat Fuel for the Production of Power. By B. F. Haanel. Pp. xiii+145. (Ottawa: Government Printing Bureau.)

A Primer of the Internal Combustion Engine. By H. E. Wimperis. Pp. xiii+143. (London: Constable and Co., Ltd.) 2s. 6d. net.

The Nature of Woman. By J. L. Tayler. Pp. 186. (London: A. C. Fifield.) 3s. 6d. net.

A New Geometry. Part i. By S. Barnard and J. M. Child. Pp. xii+224. (London: Macmillan and Co., Ltd.) 1s. 6d.

Experimental Mensuration. By H. S. Redgrove. Pp. xvii+328. (London: W. Heinemann.) 2s. 6d. net.

The Flowing Road. Adventuring on the Great Rivers of South America. By C. Whitney. Pp. 319. (London: W. Heinemann.) 12s. 6d. net.

Aëroplanes in Gusts. Soaring Flight and the Stability of Aëroplanes. By S. L. Walkden. Pp. xv+188+4 plates. (London: E. and F. N. Spon, Ltd.) 7s. 6d. net.

Cambridge County Geographies:—Forfarshire. By E. S. Valentine. Pp. viii+160+2 maps. (Cambridge University Press.) 1s. 6d.

Modern Inorganic Chemistry. By Dr. J. W. Mellor. Pp. xx+871. (London: Longmans and Co.) 7s. 6d.

The Soul of Golf. By P. A. Vaile. Pp. xiii+356. (London: Macmillan and Co., Ltd.) 6s. net.

Electricity and its Practical Applications. By Prof. M. Maclean. Pp. xiv+492. (London: Blackie and Son, Ltd.) 10s. 6d. net.

A Course of Physics, Practical and Theoretical. By Dr. C. H. Draper. Pp. xi+413. (London: Blackie and Son, Ltd.) 4s. 6d. net.

An Introduction to the Geology of New South Wales. By C. A. Süssmilch. Pp. xii+177. (Sydney: W. A. Gullick.) 5s.

Lehrbuch der Optik. By Prof. P. Drude. Dritte erweiterte Auflage. Edited by Prof. E. Gehrcke. Pp. xvi+548. (Leipzig: S. Hirzel.) 12 marks.

Elements and Electrons. By Sir W. Ramsay. Pp. ix+173. (London: Harper and Bros.) 2s. 6d. net.

Rough Stone Monuments and their Builders. By T. E. Peet. Pp. xii+172. (London: Harper and Bros.) 2s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 14.

ROYAL SOCIETY, at 4.30.—The Development of a Parasite of Earthworms: J. W Cropper.—Further Contribution to the Study of the Inheritance of Hoariness in Stocks (Matthiola): Edith R. Saunders.—The Influence of Temperature on the Absorption of Water by Seeds of *Hordeum vulgare* in Relation to the Temperature Coefficient of Chemical Change: Prof. A. J. Brown and F P. Worley.—Note on *Merlia normani* and the "Monticuliporas": R. Kirkpatrick.—The Chemical Action of *Bacillus cloacae* (Jordan) on Citric and Malic Acids in the Presence and Absence of Oxygen: J Thompson.—The Origin and Destiny of Cholesterol in the Animal Organism. X. The Excretion of Cholesterol by Man, when Fed on Various Diets: G. W. Ellis and J. A. Gardner.—The Comparative Anatomy and Affinities of the Araucarineae: Prof. R. Boyd Thomson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Address by the President (W. Duddell.)—Presentation of Premiums.

CONCRETE INSTITUTE, at 7.30.—Presidential Address: E. P. Wells.

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—Presidential Address on Recent Advances in the Theory of Surfaces: H. F. Baker.—Some Properties of Cubic Surfaces: A. B. Grieve.—The Determination of the Summability of a Function by means of its Fourier Constants: W. H. Young.—Groups of Linear Substitutions of Finite Order which Possess Quadratic Invariants: W. Burnside. The Irreducibility of Legendre's Polynomials: J. B. Holt.—The Representation of a Summable Function by means of a Series of Finite Polynomials: E. W. Hobson.—Theory of Functions of Real Vectors: E. Cunningham.

FRIDAY, NOVEMBER 15.

ROYAL GEOGRAPHICAL SOCIETY, at 8.45.—The Norwegian South Polar Expedition: Capt. Roald Amundsen.

MONDAY, NOVEMBER 18.

ARISTOTELIAN SOCIETY, at 8.—The Activity of Willing: Prof. G. Dawes Hicks.

TUESDAY, NOVEMBER 19.

ROYAL STATISTICAL SOCIETY, at 5.—Still-births in Relation to Infantile Mortality: Dr. Dudfield.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Ancient Forms of Lamps: J. W. Johnston.—A New Illumination Photometer: Haydn T. Harrison.—Some Simple Colour Boxes. W. C. Clinton. Photography in Illuminating Engineering: J. S. Dow and V. H. Mackinney.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* The Construction of the New Dock at Methil: B. H. Blyth, Jun.—Alterations and Improvements of the Port Talbot Docks and Railway during the Last Decade: W. Cleaver.

WEDNESDAY, NOVEMBER 20.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Unprecedented East Anglian Rainfall of August 26, 1912: Dr. H. R. Mill.—A Three-year Period in Rainfall: A. P. Jenkin.

GEOLOGICAL SOCIETY, at 8.—The Hafslo Lake and the Solvorn Valley (Norway): H. W. Monckton.—The Genus Aulophyllum: S. Smith.

ROYAL MICROSCOPICAL SOCIETY, at 8.—British Euchytræids. IV. The Genus Henlea: Rev. Hilderic Friend.—*Saccammina Psammosphoera* (North Sea 2): E. Heron-Allen and Arthur Earland.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL SOCIETY OF ARTS, at 8.—First Ordinary Meeting.—The Opening Address of the One Hundred and Fifty-ninth Session of the Society will be delivered by Lord Sanderson, G C.B., K.C.M.G.

THURSDAY, NOVEMBER 21.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* An Investigation of the Spectrum of Ionium: A. S. Russell and R. Rossi.—(1) A Note on the Absorption of β Rays; (2) The Similarity in Nature of X and Primary γ Rays: J. A. Gray.—The Spectra of Fluorescent Röntgen Radiations: J. C. Chapman.—Optical Investigation of Solidified Gases. II. The Crystallographic Properties of Hydrogen and Oxygen: W. Wahl.—An Electric Furnace for Experiments *in vacuo* at Temperatures up to 1500° C.: R. E. Slade.—An Investigation of the Dissociation-Pressures and Melting Points of the System Copper, Cuprous Oxide: R. E. Slade and F. D. Farrow.—Note on the Capacity Coefficient of Spheres: Dr. A. Russell.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, NOVEMBER 22.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Vapour-Compression Refrigerating Machines: J. Wemyss Anderson.—A Contribution to the Theory of Refrigerating Machines: Dr. J. H. Grindley.

PHYSICAL SOCIETY, at 5.—(1) The Law of Plastic Flow of a Ductile Material; (2) Kinematograph Illustrations of the Torsion and Breaking of Large Specimens: C. E. Larard.—A Column Testing Machine: Prof. E. G. Coker.

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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THURSDAY, NOVEMBER 21, 1912.

THE MECHANISTIC CONCEPTION OF LIFE.

The Mechanistic Conception of Life. Biological Essays by Dr. Jacques Loeb. Pp. vi+232. (Chicago, Illinois: University of Chicago Press; London: Cambridge University Press, n.d.) Price 6*s.* net.

THIS book deals for the most part with facts derived from the author's own experimental work. The facts are set forth in a manner easily to be understood, in a series of essays, most of which have already appeared in print, and the general nature of which can be inferred from their titles, viz., the significance of tropisms for psychology; the comparative physiology of the central nervous system; pattern adaptation of fishes; physiological morphology; the nature of fertilisation; the nature of formative stimulation; the prevention of death by fertilisation; the rôle of salts in the preservation of life; the influence of environment on animals. That these diverse subjects are closely interwoven and that the facts which are cited point to a definite conclusion regarding the nature of life is demonstrated in the first essay, which gives the title to the work, and it will be best to confine attention mainly to that one, since it would require more space than the Editor could fairly be expected to place at my disposal to deal at any length, and in the manner it deserves, with each individual paper of the series.

The results at which Prof. Loeb has arrived are best expressed, wherever possible, in his own words—they are, indeed, stated so clearly and concisely that it would be superfluous to attempt to set them forth in other language than that which he has himself employed.

In connection with phenomena characteristic of life, he begins by pointing out that the first attempt to reduce such a phenomenon—that of the production of animal heat—to physico-chemical terms was made as long ago as 1780 by Lavoisier and Laplace, an attempt which has now been successfully converted into accomplishment. As the author remarks, this work touches the core of the problem of life, since "oxidations form a part, if not the basis, of all life phenomena in higher organisms."

With regard to the so-called "riddle of life," Prof. Loeb of necessity admits that we are not yet able to give an answer to the question as to how life originated on the earth. Whilst leaning towards the idea of Arrhenius that life germs may be driven through space by radiation-pressure, he emphasises the necessity of attempting the "other problem"—that, namely, of producing living matter artificially. The kind of living matter that he expects to be thus produced is that which constitutes nuclear substance. For the nucleins have the peculiarity of acting on ferments for their own synthesis, and thus reproducing themselves. Whoever claims to have succeeded in making living matter from inanimate will have to prove that he has succeeded in producing nuclear material which acts in this way. "Nobody has thus far succeeded in this, although nothing warrants us in taking it for granted that the task is beyond the power of science."

Regarding fertilisation of the egg, it is shown that only a short while ago this was still "shrouded in that mystery which to-day surrounds the origin of life in general," but the problem is to-day reduced to physico-chemical terms, since activation is determined by chemical or even by mere physical agencies.

Discussing the question of the nature of life and death, "which occupies the interest of the layman perhaps more than any other problem," the author remarks that "we can well understand that humanity did not wait for experimental biology to furnish an answer. The answer assumed the anthropomorphic form characteristic of all explanations of nature in the prescientific period. Life was assumed to begin with the entrance of a 'life-principle into the body. . . . Death was assumed to be due to the departure of this 'life-principle.'" Scientifically, however, individual life "begins with the acceleration of oxidation in the egg," and "ends with the cessation of oxidation in the body." The problem of the beginning and end of individual life is thus physico-chemically clear, and the doctrine of a "life-principle" must be abandoned.

Dealing with the subject of heredity, an interesting account is given of the discovery of the sex chromosomes and their relation to the Mendelian theory. Whilst admitting that science has yet to determine the chemical substances in the chromosomes which are responsible for hereditary transmission of qualities and the mechanism by which they act, the author shows that a commencement has already been made, since it is known that for the formation of a certain black pigment transmitted through the male element, the cooperation of tyrosin and tyrosinase are required, and the chromosome must carry substances which determine the formation of these. "While until twelve years ago the field of heredity was the stamping ground for the rhetorician and metaphysician, it is to-day perhaps the most exact and rationalistic part of biology." Thus the phenomena of fertilisation and heredity, which "are specific for living organisms and without analogues in inanimate nature," are both shown to be susceptible of a physico-chemical analysis.

The question of adaptation is next dealt with. "In the answer to this question, the metaphysician finds an opportunity to put above purely chemical and physical processes something specific which is characteristic of life only." But the phenomena of adaptation only cause apparent difficulties because "we rarely or never become aware of the numerous faultily constructed organisms which appear in nature." "The number of species existing to-day is only an infinitely small fraction of those which can, and possibly do, originate," but which "cannot live and reproduce." "Disharmonies and faulty attempts in nature are the rule, the harmonically developed systems the rare exception. But, since we only perceive the latter, we gain the erroneous impression that the "adaptation of the parts to the plan of the whole" is a general and specific characteristic of animate nature." "Nobody doubts that the durable chemical elements are only the product of blind forces. There is no reason for considering otherwise the durable systems in living nature."

Lastly, the author discusses the question whether what he terms the "contents of life" or "inner life" (psychical life)—"our wishes and hopes, disappointments and sufferings"—are also amenable to a physico-chemical analysis. In spite of the gulf which separates us to-day from such an aim, he believes that it is attainable. "As long as a life-phenomenon has not yet found a physico-chemical explanation, it usually appears inexplicable." But that in the case of one's inner life such an explanation is possible is shown by the fact that we are able to explain the phenomena of animal tropisms, which are cases of simple manifestations of animal instinct and will, on a physico-chemical basis. Thus, to take as an example the tendency of certain animals—some of them by no means low in the scale of organisation—to be attracted to a source of light. This appears to be explicable by the law of Bunsen and Roscoe for photochemical effects in inanimate nature, which states that within wide limits the effect equals the product of the intensity of light into the duration of illumination; although the direct measurements in regard to the applicability of the law to animal heliotropism have still to be made. "But we may already safely state that the apparent 'will' or instinct of these animals resolves itself into a modification of the action of the muscles under the action of light; and for the metaphysical term 'will' we may in these instances safely substitute the chemical term 'photochemical action of light.'"

But the point will naturally be raised: "If we are only chemical mechanisms, how can there be an ethics for us?" The answer is that our instincts are the root of our ethics, and that these instincts are hereditary. The mother loves and cares for her children, not because metaphysicians had the idea that this was desirable, but because the instinct of taking care of the young is inherited. We seek and enjoy the fellowship of human beings because we have a hereditary impulse so to do. "Not only is the mechanistic conception of life compatible with ethics: it seems the only conception of life which can lead to an understanding of the source of ethics."

The above quotations will suffice to show that, with regard to the nature of living processes, Prof. Loeb speaks with no uncertain sound, and it would be well for biologists of the arm-chair and rostrum variety to bear in mind that he also speaks with the authority of personal experimentation and first-hand observation. E. A. SCHÄFER.

THE FRENCH ARTHURIAN ROMANCES.

The Vulgate Version of the Arthurian Romances. Edited from manuscripts in the British Museum by H. Oskar Sommer. Vol. i., "Lestoire del Saint Graal." Pp. xxxii+296. (1909.) Vol. ii., "Lestoire de Merlin." Pp. 446. (1908.) Vol. iii., "Le Livre de Lancelot del Lac." Part i. Pp. ii+430. (1910.) Vol. iv., ditto. Part ii. Pp. 399. (1911.) Vol. v., ditto. Part iii. Pp. 474. (1912.) (Washington: Carnegie Institution.)

THESE sumptuous volumes are priceless gifts to the world of scholarship by the Carnegie Institution of Washington. No one knows better than the erudite editor, whose studies of the sources available are well known, "both from a physical and from a pecuniary point of view, that no single scholar was equal to the task of producing a critical text of the vulgate cycle, even if he devoted the better part of his life to the work, and that it could be achieved, within a measurable space of time, only by the united efforts of many, all working on a common basis."

What the editor has accomplished, single-handed as he tells us, is the erection of a "fundamental structure" in the form of a "reliable printed edition of a manuscript which contained the whole cycle, and was provided with all the essentials for comparison and reference" (vol. i., pref. iii., iv.). That the transcript he presents us with may be depended on is well assured by the *modus operandi* used. The preparation of the transcript for press fully occupied the author's time for three years and seven months. "I have read every line of the printed text five times, three times with the original manuscript, once with my transcript, and finally without either" (*ib.*). For checking his reading of the original manuscript, he "constructed a sliding indicator with a cardboard ruler covered with soft leather, a strong ribbon of silk attached to a small leather-bag for the reception of a lead-weight, and a clip to be attached to the stand on which the manuscript was placed; this was easily moveable from line to line, and just as easily transferable from column to column and from leaf to leaf" (pref. xxviii.).

In his introduction (vol. i.) the editor gives an outline of his studies of the vulgate cycle, as the French version of the Arthurian prose-romances is called. That version "represents the ultimate stage in a process of welding heterogeneous elements into a not very harmonious whole" (pref. vii.). In other words, the version is the furthest removed, barring still later modifications, from the original sources. Even between that version and the older strata of the Welsh Mabinogion and their Irish analogues is a great gulf fixed, and the latter again are now well proven to be late Celtic versions of pre-Celtic traditions. The French romances throw very little light on the ultimate sources. On the other hand, the evidence of deliberate adaptation to mediæval conditions is in these volumes most apparent. The Welsh and Irish extant sources are downright pagan productions, with very little to show that we are indebted for them to Christian ecclesiastics.

The French version is, or once was, popular Christian theological literature. The core of the typical tale of the conception and birth of an illustrious child of an unknown father and a king's wife or daughter appears in the Welsh and Irish versions as something separate from any moral considerations, and while it may reflect a state of society far removed from ours, it seems fairly clear that such tales were not originally intended to represent actual human relationships and conditions, but were rather symbolical representations of phenomena. We must come down to the vulgate cycle to find in such legends the element of sin. The editor has clearly discerned the essential change which ensued in the character of the legends when he remarks: "Syr Lancelot, the title-hero of the huge romance of that name, has no prototype in Celtic literature" (pref. viii.). He is simply a Frenchman of the twelfth century. One cannot compare the groups of legends referred to without being deeply impressed with the comparative worthlessness of the French romances as guides to prehistoric cults, customs, and manners.

As French literature, the materials must, of course, be seriously treated. The editor, in justly claiming recognition for the noble work he has done, expresses himself here and there rather unfortunately.

"I shall be glad if I have succeeded in pointing out the path on which others after me may advance to success, for then I shall have done more than any scholar has achieved before me in these studies" (pref. v.). "Scholars of various nationalities have devoted much time and effort during the last seventy years to the study of the origin and growth of the Arthurian romances, but the results of their labours are comparatively insignificant, and have done little to open up this vast tract of romantic literature" (pref. iii.).

In penning such sentences, the editor must have discarded his "sliding indicator." Conscious of the soundness of his weapon—his excellent transcript—and his intimate knowledge of the subject, he appears rather eager for a free all-round fight. He announces that his study of the manuscripts concerned has led him to "results considerably at variance with what has hitherto been accepted as probable and correct" (pref. vii.). He asserts that the *matière de Bretaigne*, although undoubtedly the fountain-head of many episodes and adventures in Arthurian romance, has exercised an infinitesimal, if any *direct*, influence on the several branches of the vulgate cycle (*ib.*). He does not believe that Walter Map had anything to do with the French prose-romances (pref. xi., note). As transcribers form an absolutely indispensable class, we have learnt to tolerate almost anything they are pleased to say. To supply others with excellent texts, with never a chance to preach a sermon from them, would have been very hard lines indeed.

JOHN GRIFFITH.

GEOGRAPHICAL TEXT-BOOKS AND GUIDES.

(1) *A First Book of General Geography.* By B. C. Wallis. Pp. viii+151. (London: Macmillan and Co., Ltd., 1912.) Price 1*s.* 6*d.* (First Books of Science.)

(2) *Maps: How they are made; how to read them.* By Prof. H. N. Dickson. Pp. 66. (London: G. W. Bacon and Co., Ltd, 1912.) Price 6*d.*

(3) *Black's Modern Guide to Harrogate.* Edited by Gordon Home. Pp. 128+12 coloured plates. (London: A. and C. Black, 1912.) Price 1*s.*

(4) *Les Alpes de Provence: Guide du Touriste, du Naturaliste et de l'Archéologue.* By G. Tardieu. Pp. vi+310. (Paris: Masson et Cie., 1912.) Price 4.50 francs.

(5) *Regional Geography: the World.* By J. B. Reynolds. Pp. vii+360. (London: A. and C. Black, 1912.) Price 3s. 6d.

(6) *Libya Italica: Terreni ed Acque, Vita e Colture della Nuova Colonia.* By P. Vinassa de Regny. Pp. xv+214. (Milano: Ulrico Hoepli, 1913.) Price 7.50 lire.

(1) MR. WALLIS rightly begins his elementary general geography with a note about pictures, plans and maps, and establishes a connection between them so as to show the pupil how certain features appear (for instance) on a photograph and on a map respectively, and how a map is for some purposes a clearer representation than a picture if rightly interpreted. The book generally is on a regional basis, and the usual connection is established between climatic and other phy'cal conditions, economic and natural products, and the life of man. The whole is clear and simple, and not overloaded with detail. There are some good maps among the illustrations.

(2) There can no longer exist any excuse for ignorance in the matter of map-reading and map-construction when so convenient and cheap a book on the subject as Prof. Dickson's is accessible. It is so well produced, and, above all, so fully illustrated, that its cheapness is especially a matter for remark, while the simple explanation of scales and conventional signs of the various methods of representing relief and so forth are admirable. Incidentally we find a few useful explanations of certain terms in physical geography which are not infrequently misused, and there is also some indication as to the general inferences which can be drawn from a good map as to the nature of a country. Thus, there are some interesting paragraphs on lines of communication, with illustrations of typical routes for various types of conveyance across a given piece of country.

(3) The feature of Messrs. Black's new guide to Harrogate and its neighbourhood is that of an alphabetical arrangement under names of places, so far as concerns the environment of Harrogate, and to some extent under subjects as regards the place itself. This undoubtedly adds to ease of reference. The volume is of convenient size and light; it is also well mapped. The appreciation, or otherwise, of the three-colour illustrations may be a matter of taste.

(4) The guide under notice to the Alps of Provence is chiefly to be commended for the prominence and greater space than usual which are given to a general dissertation on the physical, geological and other natural features of the region. Apart from this, both the printing and illustrations reach a standard in advance of many guide-books printed abroad which have come under our notice.

(5) Miss Reynolds's "Regional Geography of the World" will probably be of greatest service as a topographical introduction to the regional system of geographical teaching which is now so widely applied. The general regional conclusions are deferred to the end and are disposed of briefly, though Miss Reynolds points out that it is optional to the teacher to take them at the beginning, and probably many will do so. Topography and economic products receive specially careful attention throughout the book. The maps are not always carefully printed and occasionally are difficult to read, while those given to illustrate political features of the European countries and elsewhere are old-fashioned and scarcely worth their space in the volume.

(6) The production of a volume dealing with Tripoli under the name of "Italian Libya," and bearing the date of next year, is an example of publishing enterprise not untinged with humour; but the book itself is a thorough geographical study of the region. The morphology and topography are first dealt with, and later the climate, hydrography, vegetation and other natural features are successively outlined, with appropriate bibliographies, tables and illustrations, the last in ample numbers. There is a particularly clear geological map in colour, worked out by the author.

OUR BOOKSHELF.

Customs of the World. A Popular Account of the Customs, Rites, and Ceremonies of Men and Women of all Countries. Edited by W. Hutchinson. Part i. (London: Hutchinson and Co., 1912.)

THIS is the third division of the valuable series of works on popular anthropology which we owe to the enterprise of Messrs. Hutchinson. Part i., which is now before us, sufficiently indicates the scope of the publication.

Dr. Haddon supplies a useful general introduction, in which he illustrates the importance of the subject. Custom he defines to be unwritten law. It depends primarily on the environment, that is, the conditions under which each group, the customs of which are being examined, secures its livelihood. The geographical control, while it is more marked among races the culture of which is of the primitive type, tends, with advance in civilisation, to become more or less negligible, but is never entirely lost. Generally speaking, some of the most primitive customs are those of a magical nature, intended to secure the most elementary needs of humanity, such as the periodical growth of plants or animals used for food, the causation of rain or sunshine, and so on. With the more complete organisation of the group we reach those customs which represent the influence of the collective emotion of its members, such as rites of initiation, birth, marriage, and death, all of which are social, not individual. Combined with these comes the growth of totemism and the recognition of emotions which we class indiscriminately as religious.

The first part of the work is devoted to an account of the customs in Melanesia, contributed by Mr. R. W. Williamson. Needless to say, this instalment is illustrated by a fine series of photographs.

The work, as a whole, if it does not make all its readers anthropologists, is admirably designed to excite popular interest in a most fascinating science.

Grundriss der Biochemie für Studierende und Aerzte. By Prof. Carl Oppenheimer. Pp. vii+399. (Leipzig: Georg Thieme, 1912.) Price 9 marks.

THE title of Prof. Oppenheimer's book is somewhat misleading. One expects to learn something fundamental about the chemistry of living organisms, but the subject matter is mainly concerned with the chemistry of mammalian functions.

The book is divided into two sections. The first consists of a description of chemical substances. As such it comprises a synopsis of organic chemistry with references to the biological source and significance of the substances described. The second section contains a brief outline of the chemical processes concerned in mammalian physiology.

The scope of this book indicates that it is intended for medical students preparing for their examination in physiology. The compressed descriptions render the reading dull, and at the same time the amount of information is not sufficient to make the book useful for reference purposes. Bearing these points in mind there is no doubt that the author has accomplished his purpose. There is a clear, short statement concerning the chemical properties of the different compounds found in the body, a description of enzyme action, and an outline of the chemical processes concerned in the activity of the body. A knowledge of the facts described would enable a student to pass any ordinary examination in physiological chemistry.

H. E. R.

Legends of our Little Brothers: Fairy Lore of Bird and Beast. By Lilian Gask. Pp. 268. (London: G. Harrap and Co., n.d.) Price 3*s.* 6*d.* net.

THESE stories, retold from the folk-lore of many lands, will inspire sympathetic interest in animal life in the young readers for whom they are written. From every point of view they are far better than the grotesque tales often supposed to be suitable for children. They tell of self-sacrifice, right relations of man to the creatures around him, the blessing of pity, the wrong of wanton killing, the suffering caused by thoughtlessness, the origin of the totem as the bond of union between men, and many like matters. We have read the stories with interest, and congratulate the author upon her rendering of them. As a gift-book the collection merits wide distribution.

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.]*

The Investigation of Flint.

THE remarkable body which we know as "flint" was, in the early history of mankind in this part of the world, as important, relatively to the general conditions of life, as the metal "iron" is at the present day. In order to interpret correctly the significance of fractured flints—whether as due to man's agency or to other causes—and also in order to infer from the glaze, polish, colour, opacity, or other features of a humanly worked flint what are the geological and other physical conditions to which it has been subjected, very definite and accurate knowledge of flint, only to be arrived at by careful quantitative investigation, such as the skilled physicist and chemist can bring to bear, is necessary. Yet the entire scientific world is in a remarkable state of ignorance with regard to flint.

Flint has been neglected by the geologist, mineralogist, chemist, and physicist for reasons which are not very obvious. At the present moment there is great need for a thorough study of flint, a study which no one man can undertake and carry through. At the same time, it is possible for an individual to indicate what are the lines of investigation which seem to be those which should be followed, and I venture to make the attempt.

(1) First, as to the *history* and *nature* of "flint." By the word "flint" we understand the black-looking siliceous nodules which occur in the upper chalk of this country, and have been broken up and variously altered and re-deposited in the Tertiary and Quaternary strata. Any investigation of "flint" as thus understood must include an inquiry into the history and nature of "chert," and of those flint-like concretions which occur in both Tertiary and Mesozoic strata. The history and the structure of agate must also be compared with those of flint, since geodes of agate are not only also composed of silex, but have many properties in common with flints.

It will be further necessary to distinguish and account for the varieties of flint which are known to occur in the chalk. Thus we have in the chalk of the south of England not only nodular flints disposed in distinct beds or horizons of stratification, but we have also tabular flint formed in fissures which traverse obliquely or vertically many feet of thickness of chalk strata. We have also local varieties of chalk-flints, some darker and greener when thin splinters are examined, others yellower, and others of a bluish tendency. Others, again, are somewhat grey and opaque. Some Lincolnshire flint appears to differ in this way from Brandon flint. Such differences are also to be observed in the flints of different horizons in one and the same chalk-pit.

Some observers call those flints which, after fracture, tend to develop a bluish glaze "chalcedonic"; but there are nodules which superficially look like "flints" to be found in association with ordinary black flints in the chalk of the south of England, which are apparently true chalcedony throughout, nearly transparent and colourless, with a bluish cloud in the depths. These almost invariably are oblong nodules embedding a sponge, and form beautiful objects when cut and polished. Often they contain (even when in the chalk) small quantities of iron, which produce in the transparent chalcedonic substance striking patches of red and brown colour.

Cavities occur in chalk flints as in the agate of the geodes of igneous rock, and rock crystal, as well as botryoidal chalcedony, is often found lining the cavities of the flints as of the agate geodes. Occasionally crystals of iron sulphide occur in chalk flints. We require some definite classification and recognition of the varieties of chalk flint and their probable significance. The hardness, fracture, density, and especially the elasticity of each *kind* of flint must be measured and stated.

(2) As to the *origin* and *formation* of flint, our knowledge seems to be very little further advanced than it was fifty years ago. The microscopic examination of thin sections of flint has not been applied to many varieties of flint, and, so far as I can ascertain, possible methods of staining thin sections and of applying light, heat, and chemical agents to the detection of structure and differentiation in the substance of thin sections of flint, examined with the microscope, have not been thoroughly and extensively used.

It appears to be held that the normal chalk-flint consists of extremely minute crystals of silica, cemented by opaline silica, and that the white cortex which every chalk-flint possesses is due to the removal of the opaline cementing colloid silica from the cortical region by solution. One would like to know more about this as the outcome of experiment. What is the solvent? Re-deposited flints in Pleistocene gravels are often opaque ("decomposed," it has been called) right through, and in some cases are pulverulent. How has this been brought about? Broken flints (flint implements) in Pleistocene gravels sometimes show a curious basket-work of white bands crossing and interlaced on a black ground. Is this white pattern a pre-existent structure developed by the action of a solvent? Can such a change be produced experimentally?

There is no general agreement as to the mode of origin of the flints in the chalk. It is clear from the existence of tabular flint in vertical and oblique fissures traversing great thicknesses of chalk that the flint was deposited in cavities formed after the solidification of the chalk. It is also probable that the silica deposited is the opaline or colloid silica of the spicules and shells of marine organisms mixed up with calcareous particles in the original chalk ooze, and dissolved out of it by percolating water containing some solvent—but what? What are the circumstances which have determined (1) the solution of the colloid silica of spicules, and (2) its deposition in the form of cavity-filling masses consisting of minute crystals cemented by colloid silica?

The cavities in which the nodular flints were formed were probably once filled by organic lumps and débris, but it is questionable whether the organic matter attracted the silica and determined its deposition (although we know this occurs in the silicification of tree-trunks in the sea), since flint is deposited freely in the tabular form in the upper chalk, in vertical fissures containing no organic residues. In what respects (one would like to inquire) is the mode of deposition of chalk-flint similar to, and different from, that of chert on the one hand and of geode-agate on the other? The solubility of the colloid silica of organic skeletons requires investigation. The silica deposited as agate in trap-rocks had probably a different origin from that of flint.

(3) Apart from these questions as to the intimate structure of flint, its varieties, and its origin in the chalk, there are certain more direct and simple physical investigations of flint which are necessary, and would help us in distinguishing varieties of flint, and perhaps throw light on other questions. They certainly would render it possible for archæologists to speak of facts and not merely make guesses as to the causes of the fracturing of flints found in Pleistocene, Pliocene, and other Tertiary deposits.

The most important of these inquiries are (1) as to the *porosity* of flint, and (2) as to the *fracture* of flint by blows, by pressure, by heat, and by cold. The two inquiries are closely related. It is well known that an agate geode is porous, and will absorb a large quantity of water containing colouring matters in solution. Our chalk flints are also highly porous and absorbent of water. But, so far as I can ascertain, this property has never been investigated quantitatively. It should be determined experimentally in the case of normal black flint from the chalk (and in varieties of it and in allied bodies). We require to know—

(1) What is the difference in the specific gravity of flint fresh from the chalk, and of carefully dried flint, from which all free water has been removed by non-destructive methods of desiccation?

(2) What is the maximum amount of water which such a specimen of dried flint can be made to absorb? We could thus get the coefficient of absorption of water by flint at various pressures and temperatures, also of flint lying naturally in the chalk, as compared with flint when lying on the surface and under various other conditions.

(3) Other facts as to this porosity could be accurately determined, as, for instance, in what way it is related to structure. Coloured substances might be forced into the pores, as also chemical solvents, and microscopic examination of thin sections made with very high powers.

The investigation of *fracture* is closely related to the foregoing. The most familiar and certain cause of the fracture of flint is a blow with a hammer wielded by a man. Many archæologists are (I have found) not aware that according to the character of the blow given flint may be broken with a practically flat surface of fracture, or, on the other hand, with what is called "a conchoidal fracture." The flint-knappers of Brandon break the large masses of flint removed from the chalk into blocks of convenient size by heavy blows given with what they call "a quartering hammer." The surfaces of fracture so obtained are not "conchoidal." A heavy blow in a direction perpendicular to the surface gives this plane fracture. The lighter knapping hammer gives the kind of blow which produces a conchoidal fracture, and the flint workers can produce complete cones of flint at pleasure by giving the needful kind of blow.

The exact quantitative features of the weight, velocity, and direction of this blow must be determined experimentally, as also must those of the "quartering" or plane-fracture blow. Apparatus to determine these features could be devised. It would then be possible to investigate the exact measurable characters of the conchoidal fracture or "cone" or "dome" of percussion, and to compare it in different varieties of flint. It would be very important to determine whether "saturated wet flint" has the same fractural indices as "dry" flint—whether the one fractures with conchoidal form as easily as the other, &c., &c. Then we could arrive at an answer to the question, "What weight and velocity of blow were necessary to produce the fracture (whether conchoidal or plane) exhibited by a given piece of flint?" And so it would be possible to arrive at a certainty as to whether the fractures which give shape to some supposed human flint implements could have been produced by the inter-concussion of flint nodules driven by the waves of the sea.

But in this investigation the very important fact would be exactly and quantitatively determined that the vibration tending to set up a conchoidal fracture may produce a "flaw" when the blow causing it was not of sufficient power to cause an actual fracture, and the subsequent history of such "flaws" would be experimentally studied. I have found that one of the most certain ways of obtaining a fine "dome of percussion" in black chalk-flint is to strike a "*staccato*" blow with a light hammer. No fracture results, but subsequent "tapping" with a heavier hammer causes the flint to yield along the dome-like plane of "flaw" set up by the first blow.

The fracture of flint by blows due to other agents than man has been rarely observed. At a few points on the sea-coast large flint pebbles may be picked up with one, or even six or seven, irregularly placed conchoidal fractures of the size of a haricot bean at most. Observations of the fracture of flint by torrents or by heavy wave-action are not forthcoming. The delicate pitting and granulation of the surface of flint-pebbles on the seashore is due to the action of the sea-waves causing the pebbles to knock against one another, and is a very different thing from large and uniformly "directed" fracture.

Leaving for a moment the question of the fracture of flint under graduated pressure, we must cite the action of cold and of heat in fracturing flint as demanding careful and quantitative investigation. There is no doubt that in this country the greatest "breaker of flint" is frost. In the Egyptian desert a chert-like substance allied to flint is constantly fractured by the heat of the sun. It is most important to determine whether "wet" and "dry" flint are equally subject to fracture by cold and also by heat. Has the water absorbed by porous flint any important part in its thermal fracture? The artificial fracturing of flint by the heat of camp-fires is well known as a mere fact. But the very curious structure of flint revealed by it has never been investigated.

I do not know whether anyone else has ever determined the simple fact experimentally that sudden exposure to cold will cause flint to fracture—to "fly," as the expression is in the case of glass. But last July Sir James Dewar kindly placed some large flakes of Brandon flint (prepared by the flint-knappers for breaking into gun-flints), which I brought to his laboratory, into liquid air in my presence. An extensive fracture of peculiar form, its edge having a deeply undulated margin like that of an oak-leaf, was the result. Obviously the whole subject of the fracture of flint by cold and by heat requires experimental investigation, and must yield results of great importance. I am not in a position to carry out this investigation myself, nor have I the necessary training in such determinations. My hope is that some physicist may be attracted by the subject.

An important point which I should wish to determine as bearing on the appearances presented by broken flints in Tertiary strata and gravels is whether frost can, in any circumstances, produce a *conchoidal* fracture in flint. It seems to me not improbable that a flint may by natural (*i.e.* non-human) blows, or a single blow—insufficient to break it—have acquired conchoidal "flaws," or a single conchoidal flaw, which would be developed as a conchoidal "fracture" when the flint was caused to break by sudden frost. We do not even know whether "suddenness" is an element in the causation by lowered temperature of the fracture of flint. The flints on the surface of chalk downs and in many of our later gravels are one and all broken into irregular angular fragments. This is probably correctly attributed to frost, but it would be possible to gain more precise information as to the conditions and determining causes of that fracture. The exact temperature at which, under varying conditions, fracture occurs and the possible extent and form of frost-fractures could be determined. The same is true with regard to the fracture of flint by heat.

The investigation of pressure as causing fracture of flint can be accurately investigated. What kind of fractures can be produced by pressure? And what kind of pressure can produce fracture? We have been asked to accept the statement that the pressure of sandy strata overlying flints can fracture them. By many this is considered an impossibility. We are then told of some mysterious kind of rolling or sliding pressure as producing such effects. Its action should be experimentally demonstrated.

Lastly, in regard to fracture, there seems to be a possibility that vibrations produced by very slight blows may, in special circumstances (such as great cold or heat or dryness), start large fractures in an elastic body like flint. The possibility requires experimental investigation.

There remain yet to be mentioned some other matters for experimental investigation in regard to flints. The acquirement of green, of yellow, brown, and rich red, as well as of black *coloration*, both deeply and superficially, by flint nodules and pebbles when deposited in Tertiary strata is one of these. This subject is part of the general subject of the porosity of flint. It has an important bearing on the study of the flint implements found in gravels. Of more peculiar importance is the classification of the different states of polish which broken flints, whether implements or not, present in different gravels. And with this has to be associated the study of the chemical and molecular changes of the surface of broken flints, and their curious laminar and vermicular sculpturing. Further, the deposition upon those broken surfaces of chemical material requires precise investigation. The "glaze" of the fragments of bone and teeth in the bone-bed at the base of the Red Crag is usually attributed to the deposition on them of phosphate of lime. It is not certain that this is a correct conclusion. Is the peculiar glaze of most of the broken flints from that deposit due to chemical action, or are all the glazes supposed to be present on broken flints really only different degrees of sand polish effected by wind or by water?

The wonderful flints found in small number in the Savernake gravel, which look as though they had just received a wet coat of spirit varnish, have never yet been satisfactorily dealt with. Some geologists have supposed that they owe their appearance to a chemical glaze deposited on them. But microscopical sections are absolutely contradictory of that view. Their wonderfully brilliant surface is almost certainly a water-made sand-polish. But one would like to see such polishing of an irregular surface of flint produced experimentally. And it would be important to know what were the conditions at work at Savernake to produce this polish on small Acheullian flint implements, as well as on unbroken flint pebbles of large size, and upon one and not all the surfaces of irregular fragments.

A detailed knowledge of the causes of colour and colour patterns, and of the glazing and polishing of flint implements, would enable prehistorians to give a more complete account of the historical vicissitudes of this and that implement than is at present possible. The most urgently needed of the investigations above suggested appears to me to be the experimental and quantitative determination of the causes and conditions of the different kinds of fracture of which flint is susceptible.

E. RAY LANKESTER.

November 9.

The Making of a Rostro-carinate Flint Implement.

By the courtesy of Sir Hercules Read, K.C.B., I have now been able to exhibit in the case at the British Museum containing the sub-Red Crag rostro-carinate implements a specimen which I have myself flaked, using an ordinary flint pebble as a hammer-stone, into this definite and peculiar form.

It was only after a very careful and prolonged study of one of the sub-Crag implements that I was able to recognise the plan upon which the ancient men had worked, and, after many failures, to produce a true rostro-carinate type.

I found it to be necessary to select a potato-shaped nodule of flint, and to detach a flake from one end of it, and in such a manner as to produce the ventral plane (Fig. 1). Then, having by this means got a flaking surface, I was able to remove flakes on either side of this surface and to produce the typical "keel" or carina (Fig. 2).

I may say that unless the nodule of flint is held in a particular manner when being struck the flakes detached will not be taken off at the required angle, and no "keel" will be formed.

When this "keel" is produced the flint must be undercut or cleared at the point X (Fig. 3) to form the actual overhanging "beak."

This is a very difficult task, as if a careless blow is given the end of the implement is broken off, and it is useless, a fact continually impressed upon one when making these rostro-carinate specimens. The only means of avoiding the necessity for undercutting is to detach the primary flake of such a concave shape that the necessary overhang is produced (Fig. 4).

Careful flaking will then give the "keel," and the rostro-carinate implement be complete.

I find it is sometimes necessary to detach flakes from the dorsal as well as the ventral surface to get the required form, and an examination of the sub-Crag specimens shows that their makers were occasionally compelled to adopt this method.

It was also noticed that some of the sub-Crag pieces when held with the "beak" towards one exhibited a curious one-sided appearance, which puzzled me greatly for some time.

I was also very surprised to find the specimens of my own manufacture also showed this same peculiarity. I have now found that this is due to the fact that flakes of unequal size and thickness are taken off from the two sides respectively when forming the "keel," which causes one side to get more hollowed out than the other, and the asymmetrical appearance to be produced.

I hope this description of the rostro-carinate flints will convince archæologists that we are dealing with a very complex type of implement, and that such a highly specialised tool cannot very well have been produced by unguided, haphazard natural forces.

J. REID MOIR.

12 St. Edmund's Road, Ipswich, November 8.

On an Apparent Fallacy in the Statistical Treatment of "Antedating" in the Inheritance of Pathological Conditions.

THE problem of the "antedating" of family diseases is one of very great interest, and is likely to be more studied in the near future than ever it has been in the past. The idea of antedating, *i.e.* the appearance of an hereditary disease at an earlier age in the offspring than in the parent has been referred to by Darwin, and has no doubt been considered by others before him. Quite recently, studying the subject on insanity, Dr. F. W. Mott speaks of antedating or anticipation as "nature's method of eliminating unsound elements in a stock" ("Problems in Eugenics," papers communicated to the First International Eugenics Congress, 1912, p. 426).

I am unable to follow Dr. Mott's proof of the case for antedating in insanity. It *appears* to me to depend upon a statistical fallacy, but this apparent fallacy may not be real, and I should like more light on the matter. This is peculiarly desirable, because I understand further evidence in favour of antedating is soon forthcoming for other diseases, and will follow much the same lines of reasoning. Let us consider the whole of one generation of affected persons at any time in the community, and let n_s represent the number who develop the disease at age s, then the generation is represented by—

$$n_0, n_1, n_2 \ldots n_s \ldots n_{100}, \text{ say.}$$

Possibly some of these groups will not appear at all, but that is of little importance for our present purpose.

Let us make the assumptions (1) that there is no antedating at all; (2) that there is no inheritance of age of onset; thus each individual reproduces the population of the affected reduced in the ratio of p to 1. Then the family of any affected person, whatever the age at which he developed the disease, would represent on the average the distribution—

$$pn_0, pn_1, pn_2 \ldots pn_s \ldots pn_{100}.$$

The sum of such families would give precisely the age distribution at onset of the preceding generation.

Now let us suppose that for any reason certain of the groups of the first generation do not produce offspring at all, or only in reduced numbers. Say that q_s only of the n_s are able to reproduce their kind; then of the older generation, *limited to parents*, the distribution will be—

$$q_0n_0+q_1n_1+q_2n_2+ \ldots +q_sn_s+ \ldots +q_{100}n_{100},$$

but the younger generation will be—

$$p(q_0+q_1+ \ldots +q_s+ \ldots +q_{100})(n_0+n_1+ \ldots +n_s+ \ldots +n_{100}),$$

i.e. the relative proportions will remain absolutely the same.

The average age at onset and the frequency distribution of the older generation, that of the *parents*, will be entirely different from that of the offspring, and will depend wholly on what values we give to the q's. If frequency curves be formed of the two generations they will differ substantially from each other. This difference is not a result or a demonstration of any physiological principle of antedating, but is solely due to the fact that those who develop the disease at different ages are not equally likely to marry and become parents.

A quite striking instance of the fallacy, if it be such, would be to consider the antedating of "violent deaths." Fully a quarter such deaths in males, nearly a half in females, occur before the age of twenty years. Consider now the parents and offspring who die from violent deaths; clearly there would be no representative of death from violence under twenty in the parent generation, and we should have a most marked case of antedating, because the offspring generation would contain all the infantile deaths from violence.

In the case of insanity, is the man or woman who develops insanity at an early age as likely to become a parent as one who develops it at a later age? I think there is not a doubt as to the answer to be given; those who become insane before twenty-five, even if they recover, are far less likely to become parents than those who become insane at late ages—many, indeed, of them, considering the high death-rate of the insane, will die before they could become parents of large families. Now Dr. Mott took 508 pairs of parents and offspring, "collected from the records of 464 insane parents whose 500 insane offspring had also been resident in the County Council Asylums," and ascertained the age of first attack. As at present advised, it seems to me that his data must indicate a most marked antedating of disease in the offspring, but an antedating which is wholly spurious. There is, I think, a further grievous fallacy involved in this method of considering the problem; but before discussing that I should like to see if my criticism of this method of approaching the problem of antedating can be met.

KARL PEARSON.

Biometric Laboratory, University College, London, November 11.

Is the Earth Shrinking?

I HAVE carefully looked at this question from every point of view which presented itself to me, and doubt very much whether any direct evidence will ever be forthcoming on this subject, unless it should one day be established that the changes of magnetic declination are associated with a slight difference of rotation between the core of the earth and its crust, for such a movement would have to be explained by a difference of rate of contraction between the two.

The foldings and crackings of the earth's surface have been attributed to variations in the rate of cooling of the earth. Thus whenever this rate is accelerated, the surface cools faster than the core, and should crack like a drying ball of clay; whenever the cooling rate is diminishing, as assumed by Lord Kelvin, the core should shrink faster than the skin, like a drying apple, and folding should occur. But to my mind, as recently explained in "Unity in Nature," such effects would be entirely masked by such foldings and crackings as are slowly progressing even to-day, for the sediment which is being constantly deposited on the floors of the oceans must cause the underlying strata to grow warmer and to expand in every direction, resulting in slight local risings, which are most marked near the mouths of large rivers, and in distant bulgings and foldings of the weakest lines of the earth's crust, which are the mountain ranges. On the other hand, the gradual wearing away of the surfaces of the continents and mountain ranges must cause the underlying strata to cool, to shrink, and to crack. This suggestion would certainly more than account for all the foldings, faults, and cracks to be found in the earth's crust, even if a considerable allowance be made for those cases in which the expansions and contractions occur in the same direction, and partly balance each other.

C. E. STROMEYER.

"Lancefield," West Didsbury, November 7.

THE HARDNESS OF COINS.

HARDNESS is a word which is used in various senses. In dealing with metals, it sometimes means the cutting or scratching hardness, but is more often defined briefly as the *resistance to permanent deformation*, a property which is of great importance to all users of metals. It is this kind of hardness with which those engaged in minting are chiefly concerned. When a blank is struck in a coining press, the metal is compressed and at the same time forced to flow into the recesses of the dies, and the ease with which this can be done depends on the amount of resistance offered by the metal to a force momentarily applied and tending to deform it. The hardness should therefore be measured by the effects of a sudden blow, and falling-weight machines, such as Shore's scleroscope, offer a ready means of doing this.

The hardness numbers given below are scleroscope readings, about which it may be said that a piece of metal giving a higher reading is certainly harder than a piece of similar metal giving a lower reading, but that the readings cannot be taken as proportional to the hardness, except as a rough approximation. It cannot be admitted, for example, that a specimen with a hardness number of 40 is exactly twice as hard as one with a hardness number of 20.

The application of hardness tests to the coins of the realm has resulted in some curious and interesting data being obtained.[1] It is found, naturally enough, that the blow of a coining press does not raise soft metal to a state of maximum hardness. A sovereign blank after annealing has a surface hardness of 25·5, and this is raised to 50–53 on being struck in an ordinary press, the maximum hardness of standard gold being about 76. Silver coins of similar size are hardened to much the same extent; but while sixpences, for example, have a hardness number of about 50, florins are only 37. These are the hardnesses of the "table" or flat portions of the coins, but the raised portions of the designs are much softer, especially the highest parts of large thick coins in high relief. Thus in George V. florins the centre of the effigy has a hardness of only 31, that of the annealed blank from which the coin is struck being 27·5. Such coins will evidently wear very differently from coins made in low relief, such as the modern French coins, in which the surface hardness is higher and more uniform.

The hardness of the surface of coins, however, differs widely from that of the interior. The force of the blow seems to be expended chiefly on the surface layers. When these are carefully removed, the hardness of the underlying metal is found to be considerably less. The hardness rapidly falls off with depth, and near the centre even sixpences are almost as soft as annealed silver. Old worn coins are similarly soft.

It is clear, therefore, that a freshly-minted coin has a hard skin and a soft core, and that after the removal of the skin by wear, the loss of weight in circulation will proceed very much as though the coin had been annealed before it was issued. That this is a matter of some importance is illustrated by the fact that the loss by wear of the coinage, which falls on the State, amounts to 30,000*l*. per annum for gold, and somewhat more for silver.

Annealing, one of the oldest processes prac-

[1] Memorandum on "The Hardness of Coins," 42nd Annual Report of the Deputy Master of the Mint, 1911, pp. 107–112.

tised in the arts, has had a surprisingly small share of the attention which has been paid to metals by numerous observers in recent times. Experiments made at the Mint[2] with coins and coinage alloys gave such remarkable results that the experiments were extended to pure metals, and have enabled a fairly complete account of the

FIG. 1.—Structure of pure gold after being rolled. × 11.

course of events in annealing to be clearly stated for the first time. It appears, from a large number of observations, that at comparatively low temperatures metals and alloys, hardened by rolling or hammering, are in an unstable condition, and undergo a gradual change to the soft state. The old standard silver and gold trial plates, for

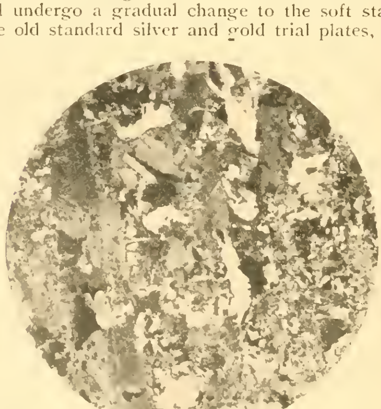

FIG. 2.—The same rapidly heated to 200° and quenched at once. × 15.

example, have in the course of centuries, at the ordinary temperature, become almost completely softened, while lead appears to soften below the ordinary temperature. As the temperature rises the change is hastened, and a *critical range* is passed through, varying in extent for different metals, below which annealing is too slow for practical purposes, while above it metals and alloys revert from the hard to the soft state almost instantaneously. During the critical range, the time required for annealing undergoes a significant reduction with each slight increment in the temperature, while above and below the critical range, the change in the time is small even with great differences of temperature.

Pari passu with softening, recrystallisation takes place, not by diffusion, but by a change in the orientation of molecules *in situ*, as predicted by Dr. Beilby. When the softening is instantaneous, recrystallisation is almost, if not equally, instantaneous. Thus, for example, pure gold, which can be annealed in a few days in boiling water, softens at once at 200°, and the large primary distorted crystals (Fig. 1) break up simultaneously into smaller irregular ones (Fig. 2). The gradual growth of crystals, which has been studied by Ewing and Rosenhain and by others, takes place subsequently without much further softening.

T. K. ROSE.

[2] "The Annealing of Coinage Alloys," Journal of the Institute of Metals, September, 1912.

INTERNATIONAL CONGRESS FOR GENERAL AND MEDICAL RADIOLOGY.

THE sixth meeting of the above congress was held this year at Prague, and was attended by a large number of scientific workers. This society has now a membership of 600, and embraces workers of many nationalities. The opening meeting took place in the Landes-Museum on October 3, and was attended by more than 2000 people. At this meeting addresses were given by Prof. Stoklasa, of Prague, who is president this year, and by Prof. Becquerel, of Paris. At the subsequent meetings of the congress, no fewer than 130 papers were read on physical, biological, and medical subjects. Among the excursions made by the members was one to the uranium mines of St. Joachimstal, from which most of the radium in use has been obtained.

The president chose for the subject of his address the action of the rays from radioactive bodies, and of ultraviolet light, on animal and plant organisms. In the first part of his speech he gave a short account of the development of our knowledge of the connection between electricity and life processes during the last two hundred years. He gave next a summary of the results of the last few years of the action of radium rays, and of ultraviolet light, on living organisms. The germination of seeds, and the development of fungi, flowers, and leaves, may be accelerated under certain conditions by these radiations, whilst, under other conditions, these processes may be entirely arrested. An intense source of α-rays from radium, for instance, has a destructive action on plant and animal organisms, while a weak source has a stimulating effect. The action of the more penetrating β-rays is similar to that of the ultraviolet rays of short wave length. These latter rays have a chemical action on the mycoplasms of bacteria and the protoplasms of plant and animal cells.

The president then gave an account of experiments of his own, in which he has shown that, under the action of the rays from radium emanation dissolved in water, seeds may germinate from two to three times as rapidly as they do in ordinary water. In other experiments he has shown also that, by acting on carbon dioxide and nascent hydrogen in the presence of ultraviolet light, a photosynthesis is effected resulting in the formation of formaldehyde, and this body itself, in the presence of potash, condenses to form a sugar. Further results indicate that photosynthesis in chlorophyll cells, and in nature generally, is due entirely to the action of ultraviolet light, or of the radiations from radioactive bodies. Chorophyll, indeed, owes its properties to the fact that it is the medium through which these radiations act on the cells. Carbohydrates are produced in nature by the action of ultraviolet light on carbon dioxide and water, and, without this synthesis, all life in any form would be impossible.

Throughout his address Prof. Stoklasa emphasised the need of biologists and of physiologists for a better understanding of the newer developments in experimental physics. A. S. R.

SLEEPING SICKNESS IN THE KATANGA.[1]

THE brochure referred to below contains the results of an investigation undertaken by the author into the distribution and other problems of sleeping sickness in the Katanga. His object is to consider the question from a general point of view and to collate the results of two years of work in the northern part of the province. He wishes to prove that "methodical work on the spot is the sole means of combating the evil in each district." If the differences presented by the districts "are lost sight of in attempting to put in practice measures prescribed in ignorance of the actual conditions, only negative, though costly, results can be obtained." With these objects in view, the author sets forth his observations upon the Katanga, its geography, commerce, and people, and upon the special problems of sleeping sickness in that country, such as the origin and progress of the disease, its diagnosis, treatment, and natural course, the distribution and occurrence of the transmitting fly, *Glossina palpalis*, and the results of administrative efforts to cope with the evil. His descriptions are supplemented by nine maps and a number of excellent photographs.

The author's attitude is mainly that of an independent observer offering gratuitous advice to the Belgian administration of the Congo; hence, doubtless, his choice of the French language for publishing his results. His foremost conclusion is that "the first thing to do is to publish the truth in Belgium"; the next, that as a necessary preliminary to efficacious measures, the zones of *Glossina palpalis* and sleeping sickness should be delimited accurately; and his third, that when the country has been carefully surveyed from this point of view the problem becomes administrative rather than medical. "For medical men the most simple and radical system of conquering the disease is to remove the people from the proximity of *G. palpalis*; it is for the administration to decide how far this is practicable." He is strongly against the treatment of the infected natives in isolation-camps, which he considers to be of little use, while difficult and costly.

[1] "La Maladie du Sommeil au Katanga." By F. O. Stohr (Oxon.) Pp. 83, with maps and illustrations. (London: Constable and Co., Ltd., 1912.) Price 4s. net

NOTES.

THE King has approved of the awards this year, by the president and council of the Royal Society, of a Royal medal to Prof. W. M. Hicks, F.R.S., for his researches in mathematical physics and investigations on the theory of spectroscopy, and a Royal medal to Prof. G. Elliot Smith, F.R.S., for his researches on the comparative anatomy of the brain. The following awards have also been made by the president and council:—The Copley medal to Prof. Felix Klein, For.Mem.R.S., of Göttingen, for his researches in mathematics; the Rumford medal to Prof. H. Kamerlingh Onnes, of Leyden, for his researches at low temperatures; the Davy medal to Prof. Otto Wallach, of Göttingen, for his researches on the chemistry of the essential oils and the cyclo-olefines; the Darwin medal to Dr. Francis Darwin, F.R.S., for his work in conjunction with Charles Darwin, and for his researches in vegetable physiology; the Buchanan medal to Colonel William C. Gorgas, of the United States Army, for his sanitary administration of the works of the Panama Canal; the Hughes medal to Mr. William Duddell, F.R.S., for his investigations into technical electricity.

AT the annual general meeting of the London Mathematical Society, held on November 14, the following were elected officers and council for the ensuing session:—*President*, A. E. H. Love, F.R.S.; *Vice-Presidents*, H. F. Baker, F.R.S., and J. E. Campbell, F.R.S.; *Treasurer*, Sir Joseph Larmor, M.P., F.R.S.; *Secretaries*, J. H. Grace, F.R.S., and T. J. I'A. Bromwich, F.R.S.; *Other Members of the Council*, W. Burnside, F.R.S., A. L. Dixon, F.R.S., L. N. G. Filon, F.R.S., J. H. Jeans, F.R.S., E. W. Hobson, F.R.S., J. E. Littlewood, H. M. Macdonald, F.R.S., P. A. MacMahon, F.R.S., H. W. Richmond, F.R.S., and A. E. Western.

AT the anniversary meeting of the Mineralogical Society, held on November 12, the following officers and members of council were elected:—*President*, Dr. A. E. H. Tutton, F.R.S.; *Vice-Presidents*, Prof. H. L. Bowman, Dr. A. Hutchinson; *Treasurer*, Sir William P. Beale, Bart., K.C., M.P.; *General Secretary*, Dr. G. T. Prior, F.R.S.; *Foreign Secretary*, Prof. W. W. Watts, F.R.S.; *Editor of the Journal*, Mr. L. J. Spencer; *Members of Council*, Mr. T. V. Barker, Mr. W. Barlow, F.R.S., Mr. F. H. Butler, Mr. T. Crook, Mr. J. P. De Castro, Rev. J. M. Gordon, Sir Thomas H. Holland, K.C.I.E., F.R.S., Mr.

B. Kitto, Prof. A. Liversidge, F.R.S., Dr. R. Pearce, Dr. G. F. H. Smith, and Mr. H. H. Thomas.

WE offer our congratulations to *The Electrical Review* upon the celebration of its fortieth anniversary. The first number of our contemporary was issued on November 15, 1872, and the current issue bears the date exactly forty years later. From the first number *The Electrical Review* has represented the best interests of the electrical profession, and has adapted itself to the great changes which have taken place during the period of its existence. How remarkable have been the developments of electrical science and engineering may be judged from a complimentary message which Sir William Preece sends to our contemporary. The prominent electrical industries in 1872 were electroplating and the electric telegraph. The Society of Telegraph Engineers (later to become the Institution of Electrical Engineers) was founded in that year, which was also the year of birth of Mr. W. Duddell, F.R.S., who now occupies the presidential chair of the institution. "The life of *The Electrical Review*," says Sir William, "is a history of the life of the electrical industry." The journal has established an important position as the organ of the practical electrician and manufacturer, and we have no doubt it will continue on its successful career for many years to come.

WE notice with regret the anouncement of the death on November 19, in his ninety-seventh year, of Mr. W. B. Tegetmeier, formerly a frequent contributor to NATURE, and whose name is well known to many naturalists. We print the following particulars of his career from an obituary notice in Wednesday's *Times*:—Mr. Tegetmeier was destined for the medical profession, and studied at University College, and though he did not qualify, the knowledge of anatomy and physiology which he acquired was of great service to him as a practical breeder and writer on poultry, pigeons, and general natural history subjects. He was a recognised authority in all that concerned pigeon racing, and his article on "Utilisation of Homing Pigeons" in NATURE of February 4, 1892, is of permanent value. In 1855 he was introduced by Yarrell to Darwin, whom he supplied with a good deal of material in the shape of skulls and skeletons, and for whom he carried out many experiments in breeding. Mr. Tegetmeier's reputation as a breeder and fancier caused him to be chosen as judge at principal shows and secured his appointment as poultry editor of *The Field*, a position which he held for more than forty years, retiring only in 1907. During this period he also contributed largely to the natural history columns of the paper, and for many years supplied the leading articles for *The Queen*. He became a Fellow of the Zoological Society in 1866, and was made an honorary Fellow in 1905; his membership of the British Ornithologists' Union dates from 1873, and he was a frequent exhibitor at the meetings of the society and of the British Ornithologists' Club. In 1854 he published "Profitable Poultry," and in 1856 edited a serial issue of Wingfield and Johnson's "Poultry Book," which seems to have formed the basis for his own "Poultry Book" in 1867; this was a great advance on any previous work on the subject, and a second edition was called for in 1873. Besides some smaller books on poultry, pigeons, and economics, Mr. Tegetmeier published "Pheasants" in 1873, and, with Colonel Sutherland, a book on horses and mule-breeding in 1895; he also edited and enlarged Blyth's articles on the cranes, and revised R. B. Morris's "British Game Birds" and F. O. Morris's "Nests and Eggs of British Birds"; and contributed the article on poultry to the ninth edition of the "Encyclopædia Britannica." The funeral will be at the Marylebone Cemetery, Finchley, on Saturday, at 2 o'clock.

DURING the session of the International Congress of Prehistoric Anthropology and Archæology, held at Monaco in 1906, a committee was appointed to secure uniformity of craniometric and cephalometric measurements. This aspect of the subject having been finally settled, the congress at a subsequent meeting at Geneva in 1912 adopted similar measures for the unification of anthropological measurements of the living subject. A translation of the rules thus adopted has been issued by one of its members, Dr. W. H. Duckworth, from the Anthropological Laboratory at Cambridge. The rules now authoritatively adopted define the position of the subject under examination and the classification of the measurements now approved. To these are added a general caution that no person should undertake work of this kind without undergoing a preliminary course of instruction, and a recommendation that anthropologists should append complete lists of measurements to their publications. The committee is to be congratulated on a scheme which will promote uniformity of measurement both of the living subject and of prehistoric remains discovered in the course of excavations.

THE Research Defence Society has issued (through Messrs. Macmillan and Co., Ltd.), at the modest price of 4*d*., an excellent pamphlet of fifty-six pages on sleeping sickness, by Dr. F. M. Sandwith. The author, after giving a brief historical account of the disease, describes fully the progress and present position of our knowledge with regard to the trypanosomiases of animals and human beings in Africa, both in their clinical aspect and from the point of view of their etiology and causation. The problems that still require solution, and their practical bearing on administrative measures having as their object the prevention and control of these diseases, are set forth concisely and clearly. This little work should be extremely useful to those especially who, without an expert knowledge of these matters, are confronted with them in the performance of their official duties. At the same time, it furnishes a most striking example of the all-importance of experiments on living animals in order to obtain the knowledge necessary to combat effectually the most terrible of all plagues afflicting both men and animals in our African dependencies.

IN addition to interesting matter in the text, a recent number of *Country Life* contains an exquisite coloured plate of a dew-spangled web of the garden spider (*Epeira diadema*) and its owner.

According to the fifth annual report of the American Bison Society, the herds of bison in the United States and Canada continue to show a gratifying increase, the total number of animals known to exist in the country at the date of the report being 2760, against 1310 four years previously.

In the report of the Horniman Museum and Library for 1911 it is stated that considerable progress has been made in the arrangement of the collections. A large decrease in attendance is attributed to the hot summer of the year under review. In a footnote reference is made to the opening of the new building in January last.

The Field of November 9 contains a photograph of a "nest," or sleeping-platform, built high up in a tree adjacent to the ape-house by an orang-utan which escaped from captivity in the Zoological Gardens on the evening of Sunday, November 3. The ape probably intended to pass the night on the platform, but, either from fear of the keepers, or on account of the situation being too cold, changed his mind, and returned to the building.

We have to acknowledge the receipt of a copy of a new and revised edition of Dr. Egid Schreiber's well-known "Herpetologia Europæa," which includes descriptions of all the species of amphibians and reptiles hitherto recorded from Europe. The present edition, published, like its predecessor, by G. Fischer, of Jena, forms a bulky volume of 960 pages, and is illustrated by a large number of text-figures, the price being 30*s*. It is of special importance on account of containing full notices of the varieties which have been described in the case of certain species. Another valuable feature is formed by the tables of the geographical ranges of all the species given near the end of the volume.

The economic importance—either beneficial or injurious—of the various species forms the keynote in Prof. W. B. Barrows's "Michigan Bird-life," a fully illustrated volume of 822 pages, published by the Agricultural College of the State to which it refers. The volume is the outcome of ten years' labour, and appears thoroughly exhaustive, so far as the present state of knowledge goes. The seventy full plates have been prepared from specially selected photographs taken by a former student of the college. The author confirms previous statements with regard to the apparent extermination of the passenger pigeon, remarking that the last wild specimen known in the United States, so far as ascertained, was killed in September, 1898, in Mayne County, Michigan. The author is of opinion that the clearing of forests and the general opening-up of the country are largely responsible for the extinction of the species, the result of this being that "the birds were driven from one place to another, and gradually compelled to nest further and further to the north, and under conditions successively less and less favourable, so that eventually the larger part of the great flocks consisted of old birds, which, through stress of weather and persecution, abandoned their nesting-places and failed to rear any considerable number of young."

The Glacial flora and fauna of the Grand Duchy of Baden have been investigated by Dr. P. Stark (*Berichte d. Naturforsch. Ges.*, Freiburg, Band xix., Heft 2), who has made a most painstaking study of the Glacial deposits in this area. The botanical portion of the work includes not only the flowering plants, but also the mosses, and not merely the relatively large remains such as stems and leaves, but such minutiæ as pollen, spores, and fragments of epidermis. This careful study is of special interest from the ecological point of view, since it contains numerous contributions to the knowledge of moorland, alpine, and arctic vegetation during Glacial and post-Glacial times. The author shows commendable caution in the matter of inferring marked changes of climate from the succession of plant remains in the "Glacial" and "inter-Glacial" peat deposits, and lays stress on the need for taking into account ecological conditions other than variations in temperature in an attempt to explain the differences in the vegetation of the superposed beds.

The Mexican cotton-boll weevil (*Anthonomus grandis*) has spread so rapidly in the southern States of America during recent years as to become the most serious pest with which cotton-growers have to contend. A detailed report on this insect and its ravages has been published by the Bureau of Entomology, U.S. Department of Agriculture (Bulletin 114), with twenty-two plates and thirty-four text-figures. An exhaustive account is given of the investigations carried on since 1895, the chief contents of previous publications on the boll-weevil being incorporated in this important memoir. The area infested by this pest has increased from 1400 square miles in 1892 to no fewer than 271,000 square miles in 1911, the average rate of spread during the last six years having been 27,000 square miles a year. At present 400,000 square miles of cotton-producing area remain unaffected, but the alarming rate of spread has led to the adoption of energetic measures for the repression of the weevil. The report is largely devoted to elaborate descriptions of the life-history, dissemination, and hibernation of the insect. Under the heading "natural control," the compilers describe the effects of temperature and other climatic conditions upon the weevil, the fungus and bacterial diseases (unfortunately very few and sporadic) to which it is subject, and the extent to which it is kept down by parasitic and predatory insect enemies and by birds. Finally, they enumerate the various methods of repression which have been tried; the most successful is that of destroying the weevils in autumn by uprooting and either ploughing-in or burning the cotton-plants.

The first sheets of *The Geophysical Journal* for 1912 (second year) have reached us. This journal forms part of "The British Meteorological and Magnetical Year Book," issued by the Meteorological Office. It gives, as before, daily values for the meteorological and geophysical elements observed at three observatories—Kew, Valencia, and Eskdalemuir—and includes, *inter alia*, solar radiation, seismology, atmospheric electricity, and terrestrial magnetism (see Nature, April 25). The new issue contains additional tables giving the results of the exploration of the free atmosphere over the British Isles by means of kites and balloons. All the units employed are based on the C.G.S. system.

PROF. H. F. REID has suggested that the initial steps in the movement which gives rise to a great earthquake might be detected by the gradual displacement of a series of pillars erected along a line at right angles to a growing fault. Another method of foreseeing the occurrence of an earthquake has been suggested by Dr. C. Davison in a recent paper (Gerland's *Beiträge zur Geophysik*, vol. xii., 1912, pp. 9–15). The method depends on the distribution of the preliminary shocks in time and space. In the case of the Mino-Owari (Japan) earthquake of 1891, it is shown that there was a marked increase in frequency of these shocks along and near the line of the fault-scarp during the four years before the earthquake. During the two years before it, the centres of the earthquakes embraced the whole region of the fault-system, clinging closely to the principal fault-lines. Before the great displacement which causes an earthquake can take place, the small obstacles to slipping must first be removed. The slips by which these obstacles are removed give rise to the preliminary shocks. The effective resistance to displacement thus becomes equalised throughout the whole fault, so that the main displacement occurs with great rapidity throughout its entire extent. It follows, therefore, that when a fault is being outlined by the epicentres of a number of slight shocks, it is probable that a great displacement throughout the region so outlined will occur after an interval which, as in the case of the Mino-Owari earthquake, may amount to a couple of years.

FOR the detection of minor fluctuations of atmospheric pressure, differentiated from the general barometric changes, a microbarograph was designed some time ago by Dr. W. N. Shaw and Mr. W. H. Dines, and was referred to in these columns (NATURE, vol. lxxi., December 29, 1904, p. 216). Dr. Yoshida, of Tokyo, claims to have made some improvements in this instrument, and Prof. Fujiwhara, of the Central Meteorological Observatory, Tokyo, has developed a dynamical and adiabatic theory in connection therewith. The apparatus consists essentially of an air chamber, connected by tubes with a cylindrical vessel containing oil, in which floats a bell-jar. The latter rises and falls with the variations of atmospheric pressure, and an attached pen records the results on a revolving cylinder. A capillary tube serves to damp the effect of the larger and slower movements, only the smaller and more rapid variations being noted. Prof. Fujiwhara gives a series of equations based on his theory in the Journal of the Meteorological Society of Japan (xxxi., No. 9, 1912). He concludes that the dimensions and mass of the apparatus itself constitute an unavoidable source of error when the barometric variations are extremely rapid. To secure the best results he recommends that the apparatus be small, and the bell-jar and its attachments of the lightest material, *e.g.* aluminium.

WHEN a liquid jet breaks into drops in the air it is well known that the drops become positively, the air negatively, charged. This effect is utilised in Kelvin's water-dropper as a means of generating electric charges, and in electrical measurements in the atmosphere to bring the instrument used to the same potential as the air at a point. The exact nature of the process by which the charges are produced is, however, unknown. The recent work of Dr. von Bernolák, of the University of Heidelberg, which appears in the *Annalen der Physik* for October, indicates that the production of the charge is intimately connected with the formation of very small secondary drops which accompany the primary drops. If the number of secondary drops formed is increased by producing large primary drops rapidly from a tube the lower end of which is widened, the total amount of charge produced is considerably increased.

THE *Electrical Review* for November 8 devotes three articles to the openings which China offers to engineers generally and to engineering manufacturers in particular. The latter are strongly urged to send out at once capable engineers as agents in order to grasp an opportunity which will pass rapidly away. One of the articles is by Prof. C. A. M. Smith, of the University of Hong Kong, and deals with the foundation and the aims of that University. From the statement of Sir F. D. Lugard, the Governor of Hong Kong, it appears that in the first instance engineering and medicine are to be the principal applied sciences taught there, while an arts course will afford an opportunity to Chinese students of making themselves well acquainted with English. A dispatch from the Viceroy of Canton to the chief officials of the Chinese Government under him is quoted by Prof. Smith, and from it we gather that considerable anxiety has been caused in China by the evil results which in some cases have followed the residence in Europe or America of Chinese students under conditions of freedom, to which they are quite unaccustomed in their own country. The new University will in all probability intercept this stream of students to foreign countries within the next few years. The drawing and plan in Prof. Smith's article indicate that the University buildings cover an area of 50,000 square feet, and occupy a fine site on a hill overlooking the harbour.

A SECOND edition of Mr. J. P. Johnson's "Prehistoric Period in South Africa" has been published by Messrs. Longmans, Green and Co. The first edition was reviewed in the issue of NATURE for August 10, 1911 (vol. lxxxvii., p. 183). The most important addition to the new edition is an appendix by Mr. Kennard, entitled "The Sequence of the Stone Implements in the Lower Thames Valley." In addition, Mr. Johnson has been able, as a consequence of the publication by Dr. Peringuey of the material in the Capetown Museum, to extend the scope of the book to the Coast Middens.

IN the 1912 volume of the Transactions of the Leicester Literary and Philosophical Society, which also contains the report of the council and annual reports of the sections, the only two papers are concerned with literary subjects. The report of the council contains an announcement that the society has decided to publish a book on the Trias by Mr. T. O. Bosworth, a member of the geological section of the society, which should be of great assistance to students of the geology of the county.

A well-arranged and excellently illustrated catalogue of their electrical specialities has been received from Messrs. F. Darton and Co., 142 St. John Street, Clerkenwell, E.C. Special attention may be directed to the large number of designs of small electric motors and dynamos this firm is able to supply. In addition, the catalogue gives particulars of a great variety of electrical appliances and accessories.

OUR ASTRONOMICAL COLUMN.

The Identity of Schaumasse's and Tuttle's Comets (1912*b*).—Using new observations made by M. Schaumasse, and extending over the period October 18 to November 1, MM. Fayet and Schaumasse have derived a set of elements for comet 1912*b* which, when compared with the elements for Tuttle's comet, taking into account the approximate perturbations of Jupiter during the period 1900–01, show that the comets are undoubtedly identical. The comet is now too low to be observed in these latitudes, its positions for November 21 and 23 being $\alpha = 11h.\ 43m.$, $\delta = -37^\circ\ 14{\cdot}7'$, and $\alpha = 11h.\ 50\ m.$, $\delta = -39^\circ\ 6{\cdot}8'$, respectively. (*Astronomische Nachrichten*, No. 4612.)

Borrelly's Comet 1912*c*.—A number of observations of comet 1912*c* are published in No. 4612 of the *Astronomische Nachrichten*, where elements and an ephemeris, extending to December 9, are also given. An observation made at the Bergedorf Observatory on November 3 gave the magnitude as 7·5, and showed that the comet was a round nebulous body with a nucleus but no tail; other observations made between November 3 and 6 gave the magnitude as 9·5, while the calculated magnitude for November 7 was 8·3. Dr. Kobold's ephemeris gives the following positions:—

Ephemeris 12h. Berlin M.T.

1912	α (h. m.)	δ (° ′)	1912	α (h. m.)	δ (° ′)
Nov. 21	19 30·2	+11 50·1	Nov. 29	19 53·1	+4 40·2
23	19 36·5	+ 9 49·9	Dec. 1	19 57·9	+3 11·6
25	19 42·4	+ 7 58·7	3	20 2·5	+1 49·4
27	19 47·9	− 6 15·7	5	20 6·9	+0 33·1

It will be seen that between November 22 and 27 the comet apparently travels along a line nearly parallel to, and about 3m. west of, that joining γ, α, and β Aquilæ; its calculated magnitude is now 9·0, and sinks to 9·5 by December 1.

Observations of Gale's Comet 1912*a*.—A number of observations, and some excellent photographs, taken by M. Quénisset at Juvisy, of comet 1912*a* are published in the November number of *L'Astronomie*. On October 16 the principal tail (p.a. = 65°) extended beyond the edge of the plate, and was at least 6° in length. The secondary tail (p.a. = 138°) was strongly curved towards the south, having the appearance of a cock's spur, and was 1° long; the successive photographs, October 6 to 16, showed that the angle between these two tails was increasing by nearly 1° per day. A third tail, near to and north of the principal, was photographed on October 14, and showed a marked dislocation at a distance of 33′ from the head. Several good spectra were secured with the Baume-Pluvinel prismatic camera, and will be reduced at M. de la Baume-Pluvinel's laboratory. They show a strong continuous spectrum, in which the usual cometary bands are shown as well-marked condensations, and the spectrum somewhat resembles that of Brooks's comet (1911*c*) at the end of October, 1911.

On November 1 the comet was still just visible to the naked eye, and photographs showed the principal tail to be 6° long with extremely undulating borders; the angle (86°) between the two tails had still further increased to the extent of 13° since October 16. Other observations of this comet are published in No. 4612 of the *Astronomische Nachrichten*.

Nebulæ and Clusters Photographed with the Crossley Reflector.—Lick Observatory Bulletin No. 219 contains descriptions of 132 nebulæ and star clusters that have been photographed with the Crossley reflector. The descriptions in many cases are extremely interesting, and are written by Dr. H. D. Curtis, who states that the modern photographic studies of nebular structure show that the visual observations made in the past are almost valueless, in comparison, even when made with powerful instruments by skilful observers. For example, in the case of N.G.C. 83, the catalogue gives thirteen nebulæ in this region, while in reality there are at least fifty small nebulæ and nebulous stars.

One or two examples must serve to illustrate the importance of the present publication. N.G.C. 1300 shows a two-branched spiral, 6′ long, where the whorls start from the extremities of straight extensions on each side of the nucleus. Nova Aurigæ on November 16, 1901, Nova Geminorum on April 23, 1903, and Nova Lacertæ on September 13, 1912, showed no traces of nebulosity, although long exposures were given in each case. With two hours' exposure the stars of Præsepe show no signs of being nebulous. N.G.C. 5921 is a very interesting spiral, with a strong oval nucleus 1·8′ long, crossed by a straight lane of matter. N.G.C. 6960 is a wonderful object, more than 1° in length, made up of bright filaments like the "Network" nebula. N.G.C. 6914 is a very irregular diffuse nebulosity about 4′ across. The neighbouring stars, BD. $+41^\circ 3731$ and 3737, are surrounded by bright nebulosity not noted in the N.G.C., although that around the second star is brighter than N.G.C. 6914.

CAPTAIN AMUNDSEN'S JOURNEY TO THE SOUTH POLE.

Captain Roald Amundsen communicated the results of his journey to the south pole at a meeting of the Royal Geographical Society on November 15, in the Queen's Hall. His expedition "landed" on the ice-barrier in the Bay of Whales, which, he observes, was charted by Ross in 1841; it is therefore to be considered, not as a casual formation of the ice, but as a permanent feature, owing its existence to shallow banks or to land beneath the ice but above sea-level. This view was confirmed by the discovery, on landing, of a surface broken by steep hills and ridges, instead of one approximately level and unbroken. The work of the expedition in laying depôts for the march to the south pole was completed in April, 1911, and it may be said at once that it was thoroughly successful, for when we follow Captain Amundsen on the journey itself it would appear (however thickly he glosses its dangers) to have been carried through with less difficulty than any of a similar character preceding it, so far as concerned food supply, the health of the party, and the condition of the sledge-dogs; there is here no tale of suffering from hunger or exhaustion, and on the return march from 86° S., the party had not even to go on fixed rations. One remarks, among other wise provisions, the practice of setting up lines of signs across the line of march for some distance on either side of some of the depôts, so that if, on the return, a deviation had been made, the depôts could still have been found. During the depôt-laying journeys a minimum temperature of $-50°$ F. was observed.

The expedition was extraordinarily favoured by the weather conditions. During the year of the sojourn in the south only two moderate storms were encountered; otherwise the wind was mostly light and easterly. During five months temperatures below $-56°$ F. were observed, and on August 13 $-74{\cdot}2°$ F. was recorded. These low temperatures delayed the start for the pole, and even occasioned a false start and an enforced return early in September. It was not until October 20 that settled weather justified the journey being finally undertaken.

In 83° S. high mountains—10,000 to 15,000 ft.—were observed to the south-west (the travellers' course lying due south). These probably belong to the South Victoria land range, and were found to be met, about 86° S., 163° W., by a much lower range trending east and north-east. The junction of the ice-barrier and the land was reached on November 17 in 85° S., 165° W. No very grave difficulties were encountered in ascending to the polar plateau between the great peaks of the above range. The greatest height, attained on December 6, was 10,750 ft., from which the plateau was found to continue flat to 88° 25′ S., and thence to slope slightly down. Progress was easy, and even leisurely. Beautiful weather was experienced; the region seemed to be one of constant calm, and even the absolutely plain surface of snow strengthened this impression. At the latitude last mentioned the last good azimuth observation was obtained. On December 14 and 15 close observations gave the latitude as 89° 55′. On December 16 the camp was removed the remaining distance to the pole, and observations were taken hourly by four men through twenty-four hours. The plateau was given the name of King Haakon VII.

So far as concerns the Antarctic land-mass, the main geographical importance of the expedition seems to lie in the observations of the great mountain-range mentioned above, which, with clear weather on the return journey, was observed from 88° S., where it was lost on the horizon, to the junction-point in 86° S., and has been given the name of Queen Maud. But three of the party, including Lieut. Prestrud, who did not accompany the southward expedition, carried out topographical work in the vicinity of the Bay of Whales, and east of it as far as Scott's King Edward Land, while Captain Nilsen, in the course of cruising which extended from Buenos Aires on one hand to Africa on the other, made oceanographical observations at sixty stations, and by navigating the *Fram* to a point further south than any known vessel had reached before, set the crown on the fame of that ship in polar exploration.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

NOTWITHSTANDING the unfortunate overlapping in the dates of the meetings of the Association and the International Congress of Prehistoric Archæology at Geneva, which seemed likely at one time to affect seriously the attendance of anthropologists at Dundee, the proceedings of Section H (Anthropology), which met this year under the presidency of Prof. G. Elliot Smith, F.R.S., were, if anything, of even greater interest than usual, and included several communications of considerable importance. The attendances throughout were good, and if, in the first half of the meeting, the discussions were a little below the customary standard, this was due to lack of time rather than to lack of interest, and was more than counterbalanced in the second part of the meeting, when the problems of Mediterranean archæology and the President's views on the origin and distribution of megalithic monuments gave rise to animated interchanges of opinion.

In any detailed review of the papers presented to the section it would be necessary, on more grounds than one, to give a prominent place to the two communications by Prof. Anthony, of Paris, who attended the meeting as the distinguished guest of the section. These dealt respectively with the suprasylvian operculum in primates with especial reference to man, and the brain of La Quina man, one of the earliest and the finest of the brains of Palæolithic man yet known, and now described for the first time. With these two papers must be included Prof. Keith's exhibit of the brain of Gibraltar man, the three forming a group pendant to the President's address, and affording further evidence in support of his conclusions as to the evolution of the human brain, and in particular of the association areas.

Other communications also dealt with early types of man. Dr. Duckworth's description of the fragment of a human jaw of Palæolithic age found in Kent's Cavern, Torquay, in 1867, but previously undescribed, in the absence of the author was appropriately presented to the section by Prof. Boyd Dawkins, who was a member of the committee appointed to explore Kent's Cavern which recorded the discovery in a report presented to the Association at the Dundee meeting in 1867. On anatomical grounds, Dr. Duckworth considers the jaw to belong to the Neanderthal type. Dr. Ewart gave an account of an important find of human remains in a raised beach at Gullane, the skeletons being described by Prof. Keith. When the results of this discovery are published in full, they will be found to have an important bearing upon the prehistory of the Scottish area. In the discussion which followed the reading of the paper, Prof. Bryce stated that, in his opinion, the skeletons found in association with the very early types of Neolithic implements represented the earliest type of man yet discovered in Scotland, antedating the men whose remains have been found in the cairns of Tiree.

Other papers dealing with the physical side of the study of man were Dr. Duckworth's contributions to Sudanese anthropometry based upon measurements made in the south-eastern Sudan by Dr. Atkey; Dr. Wood Jones's papers on the lesions caused by judicial hanging, in which injuries received by criminals executed in Egypt in Roman times were contrasted with those received in modern instances, and on the ancient and modern Nubas, in which he suggested an origin for the foreign immigrants into Nubia in the early Christian era whose remains have been discovered by the Archæological Survey of Nubia; Mr. D. E. Derry's description of a macrocephalous skull from Egypt; and a highly interesting paper by Mr. L. Taylor on the Bontoc Igorots now exhibited at Earl's Court, based upon measurements which suggest that these people may not be of such unmixed Indonesian stock as has usually been supposed.

Two organised discussions were largely attended and aroused much interest. The discussion on the ethnological aspects of Scottish folklore was opened by Mr. Crooke with a paper on customs connected with the Scottish calendar, followed by Mr. Hartland with a paper on folklore as an element in history. Canon J. A. McCulloch, after a reference to features in

Scottish folklore common to other countries, contrasted the form taken by the fairy belief in the Highlands and the Lowlands, and Mr. Brodie-Innes, in a paper covering a wide range of fact and theory, adduced data for distinguishing Celtic, Saxon, and Scandinavian elements in Scottish beliefs and practices. Miss Burne urged the importance of the collection of evidence, especially in border counties, before it should be too late.

It would be unfair to attempt to summarise in a few words the arguments put forward by Prof. Elliot Smith in opening the discussion on megalithic monuments and their builders in support of his views that this form of sepulchral monument originated in Egypt at about the time of the first utilisation of copper implements, and spread thence as a religious idea to the remaining parts of the world in which megalithic monuments are found. Mr. Peet, in a paper which, in the absence of the author, was presented to the section by the President, while assigning a single origin at some one centre to these monuments, ascribed their distribution to a racial migration. These views were sharply criticised in the discussion which followed, strong exception being taken to a theory which derived the round form of megalithic monument from the square Egyptian tomb. Among the speakers were Prof. Boyd Dawkins, Prof. Ridgeway, Prof. Myres, and Prof. Bryce.

Communications dealing with the archæology of Egypt and the Sudan were numerous. Prof. Petrie described his excavations during the last season on an early dynastic cemetery near the village of Tarkharn, thirty-five miles south of Cairo, which in his opinion is the earliest site as yet discovered so far north. Mr. Quibell described the excavation of second and third dynasty tombs at Sakkara, which led to the rediscovery of the tomb of Hesy and revealed a style of mural decoration previously unknown. Prof. Elliot Smith gave the results of his examination of the bodies found in these excavations, carrying back the evidence for an alien population in Egypt to the second dynasty. One of the bodies examined showed an attempt at mummification. This is the earliest evidence for this method of preserving the body which has yet been discovered. He also described the work of the Boston Museum and Harvard University expedition in Egypt from material provided by Prof. Reisner, who is in charge. Mr. Ogilvie gave an account of Prof. Reisner's work under the Archæological Survey of Nubia, and showed slides of his own sketches, recently made, of the ruins of the temples at Philae, which are shortly to be submerged by the irrigation works. It would be difficult to praise too highly Mr. R. Mond's coloured slides of the Theban tombs excavated by Mr. Alan Gardner, which were greatly admired, both for their exquisite beauty and their value as accurate records of the objects discovered.

An important communication by Mr. H. S. Wellcome described for the first time the result of two years' work on a site containing remains of primitive Ethiopian races in the southern Sudan, from which he has obtained a large quantity of implements, pottery, ornaments, and other Ethiopian and Egyptian objects, ranging in date from the neolithic age to the Ptolemaic period. Dr. Derry discussed the phenomenon of the red pigment found on ancient bones, and came to the conclusion that in the Nubian and Egyptian examples it was due to a red pigment applied to the grave wrappings and afforded no evidence of mutilation after death.

The interest in the problems of Mediterranean archæology shown by the members of the Association who attend this section has been so marked in the past that it was gratifying to find this subject again becoming prominent in the proceedings. Mr. Wace gave an account of the excavations carried out by himself and Mr. Thompson in tombs and a tumulus belonging to the early Iron age at Halos in Achaia Phthiotis, which contained "geometric" pottery, bronze fibulæ, and swords, knives, and long spears of iron. Prof. Ridgeway described a group of bronze and iron javelins found together in Caria, and now in his possession, which illustrate the overlapping of the use of bronze and iron. Prof. J. L. Myres presented the report of the Committee on Archæological and Ethnological Investigations in Crete, which contained a further instalment of Dr. Duckworth's report on the measurements made when he visited the island some years ago on behalf of the committee. Dr. Ashby gave an account of recent excavations of the prehistoric monuments of Malta, Gozo, and Sardinia, which was in part a supplement to the discussion on megalithic monuments from the point of view of the evidence furnished by these islands.

The papers dealing with the archæology of Britain were few in number, but of considerable interest. Mr. Willoughby Gardner described the excavation of an interesting hill fort in Parch-y-Meirch Wood, near Abergele. The fort was evidently British in origin, but showed signs of three occupations, one being by the Romans. Miss Leslie-Paterson exhibited a series of pigmy flints from the Dee Valley, the first examples of the actual implements to be found north of the Forth, and the Rev. Father Blundell presented the report of the Committee on the Artificial Islands in the Lochs of the Highlands of Scotland. The committee, which was appointed at the Sheffield meeting, has now completed two years' work; a considerable number of these islands has been recorded, and much interest in them has been aroused locally. Papers by Mr. Marett on a Neolithic cemetery on the islet of La Motte, in Jersey, and by Dr. Irving on further investigations on a prehistoric site in the Valley of the Stort were presented to the section, but, in the absence of the authors, were not discussed.

Two important technological points were raised by Dr. Rivers, the first being the disappearance of useful arts, and the second "conventionalisation" in art. In regard to the former, he entered a caution against over-hasty conclusions as to the character and extent of a primitive culture, by pointing out that it was possible, as he had found in Melanesia, for a useful art to die out of everyday life and leave no trace of its existence in the technology of the people by whom it had been practised. In the second of his papers, to explain the problem which is not completely solved on any of the current theories of the development of decorative art, namely how it comes about that a realistic representation should become a geometrical figure, he offered the hypothesis that in the clash of cultures of two races with different art motives and forms there may result the retention of the motive from one side and of the form from the other. In another branch of the study of primitive art, Dr. C. S. Myers's phonograph records of Sarawak music were greatly appreciated by a large audience.

Among other ethnographical papers, mention must be made of Mr. Amaury Talbot's description of tribes of the West and Central Sudan with numerous illustrations of racial types, implements, and ornaments, Mr. MacRitchie's paper on the magic drum of the northern races, and Miss E. B. Lindsay's paper on an undescribed totem post of stone from British Columbia.

In conclusion, two statements made to the section may be placed on record. Dr. George Bryce sent a report on the first eighteen months' work of the ethnographical department of the Geological Survey of Canada, which, it will be remembered, was a direct outcome of the visit of this Association to Winnipeg in 1909, and Dr. Hrdlička, in a letter from Siberia addressed to the President, announced that he had discovered in north-eastern Asia living representatives of the ancient race which gave North America its Indians.

BIRD NOTES.

IN an article on the food of nestling birds published in the Journal of the Board of Agriculture for September, 1912, Mr. W. E. Collinge commences by referring to the fact that in the early stages of life birds daily consume more than their own weight of food. It is also mentioned that since nearly all birds except pigeons feed their young upon an animal diet, and that the nesting season occurs when insects are most abundant, the value of birds as insect-destroyers is self-apparent.

In *Witherby's British Birds* for October an instance of one cuckoo laying in the nest of a marsh-warbler and of a second in that of a rock-pipit are recorded. Only about five instances of a similar event have been previously recorded in the case of each species.

To *The Zoologist* for October Mr. Harvie Brown contributes the first part of an article on the past and present distribution of the fulmar petrel on both sides of the Atlantic, and its recent spread in northern Britain.

For about a century naturalists were content with the name *Strix flammea* for the barn-owl. The late Prof. Newton proposed to replace the generic name by Aluco, but this usage was recently stated by Mr. G. M. Mathews to be invalid. In No. 4 of *The Austral Avian Record,* after referring to a couple of alternative generic designations, the same writer brings forward the name *Flammea vulgaris* as one to which no objection can be taken. It seems a pity to try to displace a name which has become almost a household word. This replacement of long-accepted names of British birds by others of earlier date forms the subject of an editorial article in the September number of *The Scottish Naturalist,* where it is remarked that "though our sympathies are strongly in favour of the British Association's rules, yet we are willing to view the present situation in a liberal spirit. There must, however, be concessions, and we regard it as essential that a number of time-honoured names must be conserved."

In the above-mentioned issue of *The Scottish Naturalist,* Mr. Eagle Clarke describes, with an illustration, a male hybrid between an eider drake and a wild duck, which was shot early in 1912 in the Orkneys. What appears to have been a fellow-hybrid was seen on the Pentland Skerries in the following May. No other instance of a similar hybrid appears to be on record.

We are indebted to Mr. W. Junk, of Berlin, for a copy of a sale catalogue of ornithological literature.

R. L.

REPORT OF THE METEOROLOGICAL COMMITTEE.

THE report of the Meteorological Committee for the year ended March 31, 1912, shows that several important matters were dealt with during that period, *e.g.* the reconsideration of the relations with the Post Office as regards weather telegraphy, the incorporation in the official network of stations which had previously sent their observations to the Royal Meteorological Society, the publication of results of various classes of observations, and the revision of rules under which the increasing number of telegraphic reports from health resorts can be accepted for communication to the Press.

The present capabilities of international and wireless weather telegraphy are well illustrated by the frontispiece synoptic chart for April 1 of the distribution of weather phenomena over a large part of the northern hemisphere compiled from data received within ten days of the date of the chart. One great advantage has been conceded by the Post Office at the request of H.M. Treasury in allowing priority of transmission to certain classes of meteorological telegrams and to storm warnings; but very much still remains to be effected in the way of facilitating the telegraphic distribution of forecasts to all parts of the United Kingdom by some financial arrangement by which the Meteorological Office would be placed on a better footing in carrying out its important public work than that accorded to a "private person."

The percentage of complete success and the sum of successes (complete and partial) of the 8h. 30m. p.m. forecasts for the year 1911 were both higher than in any year since 1879, when the present service of daily forecasts was inaugurated. The "further outlook" frequently appended to the forecasts for twenty-four hours has also been remarkably successful. Want of space precludes special mention here of the useful work carried on in other departments of the office.

THE METALS IN ANTIQUITY.

THE Huxley memorial lecture was given by Prof. W. Gowland, F.R.S., on Tuesday, November 19, at the Royal Anthropological Institute, the subject being "The Metals in Antiquity." After pointing out the sources whence our knowledge of the use of metals by man in prehistoric and protohistoric times was derived, the lecturer gave an account of the primitive metallurgy of copper, tin, gold, lead, silver, and iron, the conditions under which they were extracted from their ores, and the localities in which they were first obtained.

The origin of the smelting furnace was traced to the camp fire, in which, if by chance a lump of ore either of copper carbonate, tin-stone, or brown iron ore or hæmatite, had been one of the ring of stones surrounding the camp or domestic fire and had accidentally become embedded in its embers, it would undoubtedly be reduced to metal.

The metals which occur—native copper, gold, and iron—were undoubtedly the first to be known to man in the localities in which they occurred, but until the art of smelting metals had been invented, the discovery and use of the native metals was insufficient to affect to any great extent the old Stone age culture.

Gold, although doubtless the first metal to be known in many localities owing to its wide distribution in the sands of rivers, was useless for any practical purpose.

Copper, however, or an alloy of the metal with tin, antimony, or arsenic, was extracted from ores at a very remote period, and it or its alloys was the first to be applied to practical use. In fact, the first metal to be obtained by primitive man by smelting copper ores depended on their composition, and in the localities where tin did not occur it was a more or less impure copper.

The extraction of gold from its ores on a large scale in the earliest times was attributed to the Sudan district of Egypt, and the primitive tools and methods employed at the mines were described.

Egypt was also noted for having produced the first mining map in the world, a map showing a gold mining region of the time of Seti I. or Rameses II. (1350 to 1330 B.C.).

The influence of silver and lead on the development of primitive culture was shown to be insignificant, the latter metal only becoming of importance during the supremacy of the Romans, in connection with their elaborate systems for the supply and distribution of water and in the construction of baths.

As regards iron, the belief that the first iron generally known to man was either of meteoric origin or telluric native iron was not supported by any substantial evidence. Nor was such origin necessary, as iron ores are so easily reducible that they can be converted into metallic iron in an ordinary charcoal fire. They are, in fact, reduced to metal at a considerably lower temperature than the ores of copper.

The earliest iron smelting in Europe was traced to the upper waters of the Danubian tributaries, the ancient Noricum, but in still earlier times iron was extracted from its ores in the region on the south-east of the Euxine, in Ferghana and other localities in Asia. In Africa, so far as metallurgical evidence may be depended on, the extraction of iron from its ores was carried on at a remote date. That this early African iron smelting was known in Egypt is well shown by a bas-relief on a stone now in the Egyptian collection in Florence.

THE BORDERLAND BETWEEN ELECTRICITY AND OTHER SCIENCES.[1]

THERE are applications of electricity that give work to many men, applications which employ much plant and apparatus, and on which large sums of money are spent, about which we have heard very little or nothing in the institution. Again, we hear little, if anything, about what is occurring on what I may term the borderland between electricity and the other sciences. In this borderland or fringe a large number of scientific workers are quietly at work, and what is to-day a laboratory experiment may to-morrow form the basis of a large industry. Finally, we should have an opportunity of discussing the many details in the design and operation of electrical plant and apparatus, the importance of which cannot be overestimated.

Wireless Telegraphy and Telephony.—Corresponding to each spark at the transmitter of a wireless telegraphy plant, a train of oscillations is received, and these trains of oscillations are rectified by the detector, and in general are passed through a telephone as an indicator. At each spark a click is heard in the telephone, so that with 600 sparks a second the diaphragm is attracted 600 times, producing a somewhat musical note.

Herein lies one of the great advantages of high-spark frequency.

There seems no doubt that the combination of the human ear and a telephone is much more sensitive for high-frequency notes than for low. In some tests I have made, using an alternating current to determine the minimum power required to produce an audible signal in a telephone receiver at different frequencies, I found in one case that the power was reduced from 430 micro-microwatts at 300 frequency to 7·7 micro-microwatts at 900 frequency. At higher frequencies it increased again.

[1] From the presidential address delivered to the Institution of Electrical Engineers on November 14 by Mr. W. Duddell, F.R.S.

Due to atmospheric causes, there is generally audible in the telephone receiver clicks and noises commonly spoken of as atmospherics or strays. With high-spark frequencies the human ear easily distinguishes the musical note from these atmospherics; this enables the operators to read through a large amount of extraneous interference. The elimination or compensation of these atmospherics is one of the most important outstanding problems in wireless telegraphy.

When operating with continuous waves practically no note is heard in the receiver telephone unless the currents are chopped up into rapidly recurring groups of waves either at the transmitter (tone sender) or at the receiving end (ticker).

In order to make a permanent record of the signals, and to allow of high-speed working, the rectified current from the detector may be passed through a galvanometer or a relay, and here we come to one of the difficult problems which requires solution, namely the construction of a relay or recording instrument which will make a record of the very small received currents at high speeds. The Einthoven or string galvanometer, which is at present used for this purpose, is delicate and gives a photographic record.

Although the difficulties may be minimised, I do not feel at this moment that the photographic method of recording, with the attendant chemicals, and the necessity of handling moist slip, can be looked upon as the final solution from the point of view of commercial telegraphy.

The problem of constructing a relay for this purpose is a very difficult one. The mean current strength of the signals, after rectification by a high-resistance detector, is of the order of $\frac{1}{10}$ to $\frac{1}{100}$ of a microampere, and the amount of power available to work the instrument is only of the order of a few micro-microwatts. For high-speed reception the number of contacts to be made and broken per second may be anything up to fifty. The problem before our instrument-makers is to construct a relay or recorder which will operate with a power not exceeding a few micro-microwatts at the rate of fifty signals per second.

Of the sister science, namely wireless telephony, there is not so much to relate. A certain amount of progress has been made, but the details of the methods used have not been made public. The principle is simple. Given continuous oscillations or a spark frequency above the limits of audibility, you may vary the antenna current, and hence the radiation by means of a microphone, in the same way as a continuous current is varied by the microphone in ordinary telephony. As the radiation varies according to the modulation of the current by the voice the received current will be varied in the same manner and the voice will be reproduced. The difficulties are mainly in the transmitter. First, we require a perfectly steady source of continuous oscillations, and secondly a microphone capable of modulating the large powers required to transmit any distance. Over short distances of a few miles there are no difficulties. It is only when we come to distances of fifty to 100 miles that the engineering problems become troublesome. In view of the progress that is being made in the high-frequency alternator, and of how much more easy it is to modify the power given out by an alternator, it will not be surprising if, as soon as high-frequency alternators are in use, wireless telephony over comparatively long distance becomes a working possibility.

Electrochemistry and Electrometallurgy. — The amount of power installed for chemical and metallurgical purposes is very large indeed. Exact data are wanting, but it seems probable that the power employed in these processes in Norway and at Niagara may already reach 1,000,000 kw. One of the necessities of our industry, namely copper, is largely purified by electrical means. Aluminium, calcium carbide, carborundum, sodium, and potassium are wholly prepared electrically. The only hydroelectric stations of any size that have been built in this country are used for electrochemical purposes. The production of aluminium alone at Loch Leven absorbs some 30,000 kw.

The production of disinfectants electrolytically is being worked on a small scale. In Poplar the formation of a solution of chlorine in water by means of electrolysis is in practical use. Although one cannot anticipate very large powers being required for this purpose, yet if the demand for electrolytic disinfectants all over the country was the same as in Poplar, it would require about 2,000,000 units per annum, all of which could be supplied at such times as would help to level up the load curve.

Electromedical apparatus.—The design of induction coils for the production of X-rays has advanced a long way of late years, and some of the latest pieces of apparatus for the production of the discharge through the X-ray tube involve considerable ingenuity and engineering design. The discharge must be undirectional and at a high pressure, say, 50,000 volts or more. One method to obtain this is to step up by means of an E.H.T. transformer and to rectify the secondary current. Another method of working to obtain practically instantaneous photographs consists in switching the primary of the transformer straight on to the direct-current mains, when the current rush instantly blows the fuses. This interruption of the current produces one powerful discharge on the secondary, which, passing through the X-ray tube, suffices for the photograph. I do not know how the supply companies view this method of operation, because the rush of current must be pretty considerable, as the apparatus is not constructed on a particularly small scale. The transformer weighs about half a ton.

Electricity and Chemistry.—We are all of us acquainted with the brush discharge, yet how much do we know of its mechanism? In our high-tension machinery we are mainly occupied with trying to get rid of it and its injurious effects. Yet it has its uses. Nearly all the information in our proceedings deals with the negative question, namely how to avoid it.

Now the brush discharge has a peculiar property of producing that modification of oxygen known as ozone, which is without doubt a strong sterilising agent, and which may in the future have considerable applications. A modification of the conditions of the production of the discharge will cause the formation of oxides of nitrogen instead of oxides of oxygen. Oxides of nitrogen are of great commercial importance, and their production by electrical means will probably be one of the most important industrial applications of electricity.

Already in Norway between 100,000 and 120,000 kw. are employed working day and night for this purpose, and it is stated that this power will shortly be increased to nearly 250,000 kw. The main object of fixing the atmospheric nitrogen is to form a substance to replace Chile saltpetre. The demand for this is yearly growing at an increasing rate.

Last year about 125,000 tons of nitrate were imported into this country. To produce the equivalent amount of fixed nitrogen per annum would, on the basis of Norwegian plants, require about 150,000 kw.

At the moment I believe that the cost of electrical power is the chief stumbling-block to the introduction of the manufacture on a large scale in this country.

Electricity and Sound.—I do not know of many researches on the efficiency of the telephone receiver, yet the question is really a practical one and of considerable importance. The telephone receiver may be looked upon as an alternating-current motor. It receives electrical energy, which it converts into the mechanical form in the motion of its diaphragm, which energy is transmitted to the air as sound waves. There is no special difficulty in measuring the electrical energy supplied to the telephone receiver to a moderate degree of accuracy. The amount of this energy that is transmitted to the diaphragm is much more difficult to estimate. The real difficulty is the determination of the amount of energy of the sound waves. If we possessed any apparatus by means of which we could measure energy of sound waves we could not only determine the efficiency of the telephone receiver, but the apparatus would have many other useful applications. It is curious to think that up to the present we have no unit or standard of sound. We cannot specify its strength or intensity. Even the comparison of two sounds by the ear is very inaccurate; nowhere near as accurate as the comparison of two lights by means of the eye. This want of standards and methods of measurement is, I believe, one of the causes that has retarded progress in the science of sound. Can electricity, the handmaid of all the other sciences, help in this direction?

Electricity and Radiation.—Much work is quietly going on, of which we in the institution hear nothing, to try to unravel completely the mechanism of the transfer of electricity through gases. There is much to be hoped for along these lines. The elaborate glass apparatus, the vacuum tubes, the mercury, the liquid air, &c., which are being used in the research make the experiments look most unpromising from the practical engineer's point of view. Yet some progress is being made in electric lighting by means of the passage of electricity through gases. Many members will remember the vacuum tube, 176 ft. long, which was used to light the courtyard of the Savoy Hotel. That tube, I believe, contained nitrogen, and according to the tests of Prof. Fleming, gave an efficiency of 0·56 candle per watt. About a year ago I saw a tube, not such a long tube, filled with the rare gas neon, obtained from the residues in the manufacture of liquid air. This tube gave a most beautiful rose-coloured light. If this rare gas were obtainable in sufficient quantities we might have a rival to the flame arc. I may mention in passing that tubes containing neon are now commercially obtainable, and are claimed, in the larger sizes, to have an efficiency as high as two candle-power per watt. Further researches on the borderland between electricity and radiation will no doubt provide us with still more efficient sources of light.

We are at present very far from any practical means of converting the energy of radiation directly into electrical energy, although on a small scale this conversion really takes place in many photoelectric arrangements. For instance, the action of the light on the liquid potassium sodium alloy has been shown by Prof. Fleming to produce a voltage as high as 0·6 volt when the liquid alloy and a platinum plate are enclosed in a highly exhausted tube, and the liquid alloy is illuminated strongly. There seems little doubt that the current that is generated in this case is produced from the energy of the light that is absorbed.

The effects so far obtained are extremely small. At the most only a few microamperes are obtainable with very strong illumination. Nevertheless, this property of sensitiveness to light, though at the moment it has no practical applications, may at any time be found to fill some useful purpose and make another case illustrating how observations that are one day on the borderland of science may shortly afterwards be of practical use in engineering.

When it is remembered that the water-power in Norway alone is estimated to produce several million kilowatts, it is evidently better, for the present at any rate, for engineers to utilise the solar radiation by harnessing the waterfalls rather than by attempting to build radiation traps in the Sahara.

UNIVERSITY STUDENTS IN STATE-AIDED INSTITUTIONS OF ENGLAND AND WALES.

An article on the budgets of certain universities and university colleges, based on the reports for the year 1910–11 from universities and university colleges in Great Britain in receipt of grants from the Board of Education, was published in the issue of NATURE for August 15 last. These reports also contain a great deal of information concerning the number of students in the various colleges, their ages, the subjects they are studying, and so on; and we have abstracted the subjoined facts from them and the introductory statement signed by the President of the Board of Education.

Before summarising the statistics under these headings, it is well to point out that the numbers which follow concern the following English universities:—Birmingham, Bristol, Durham (Armstrong College), Leeds, Liverpool, Manchester, Sheffield, London (including University College, King's College, Bedford College, School of Economics, and East London College), and also the University Colleges at Nottingham, Reading, and Southampton. The University of Wales includes the University Colleges of Aberystwyth, Bangor, and Cardiff.

Certain other constituent colleges of universities are in receipt of aid under "The Statement of Grants available from the Board of Education in Aid of Technological and Professional Work in Universities in England and Wales." These institutions are twelve in number, nine being medical schools attached to hospitals in London. They are all schools of the University of London. One, the Newcastle College of Medicine, is a constituent college of the University of Durham, while the two remaining, namely, Manchester Municipal School of Technology and the Bristol Merchant Venturers' College, make provision for the faculties of technology and engineering respectively in the universities to which they are attached.

NUMBER OF FULL-TIME STUDENTS, 1910–11.

	England	Wales
Degree students:—		
Training college	1459	451
Others	3512	702
Total	4971	1153
Non-graduate (diploma) students:—		
Training college	729	—
Others	1100	105
Total	1829	105
Post-graduate students	477	75
Others	628	58
Total	7905	1391

NUMBER OF PART-TIME STUDENTS, 1910–11.

	England	Wales
Day.		
Degree	254	11
Non-graduate (diploma)	112	4
Post-graduate	809	15
Others	2987	286
Evening.		
Degree	494	
Non-graduate (diploma)	810	—
Post-graduate	173	—
Others	7298	
Total	12937	316

In addition, there were in England 277 evening students studying for matriculation and nine such students in Wales.

The number of full-time students in England during the year 1910–11 was 7905, as compared with 8174 in the previous year. This apparent drop of 269 is, however, more than accounted for by the stricter classification adopted. A number of students taking post-graduate and special courses have this year been clsssified as part-time students. The number of full-time degree and diploma students, on the other hand, increased by 150, and the real increase was larger since the figures for the earlier year included 78 engineering students at the Bristol Merchant Venturers' College who were included in the returns for Bristol University, but have this year been shown separately. The establishment of a somewhat higher criterion and the consequent exclusion of a certain number of students who simply attend a certain number of lectures render it somewhat difficult to make any detailed comparison of the figures for part-time students with those for the previous year, but it seems safe to say that the apparent reduction in the total number of part-time students is more than accounted for by the reduction in the number of "Other" students, many of whom could scarcely be regarded as serious students, and have consequently been excluded altogether. On the other hand, the number of part-time students taking degree, diploma, or post-graduate courses showed marked increase. It follows that the reduction in the total number of all kinds of students is not to be taken as implying any diminution in the number of genuine students; on the contrary, there is good reason to think that the number of such students is on the increase. In support of this view it may be pointed out that the total number of post-graduate students has increased since the previous year by more than 200.

In Wales there has been a small increase in the total number of full-time students; on the other hand, there has been a drop in the number of part-time day students.

AGE AT ADMISSION OF FULL-TIME STUDENTS.

	England	Wales
Number admitted during 1910–11	3587	405
Percentage under 17	3·8	3·9
Percentage 17–18	12·0	14·4
Percentage 18–19	23·9	31·2
Percentage above 19	60·3	50·5

The number given above under England include 277 students at the nine medical schools of the University of London and 29 students at the Newcastle College of Medicine, which is a constituent college of the University of Durham.

NUMBER OF FULL-TIME STUDENTS IN THE VARIOUS FACULTIES, 1910–11.

	England	Wales
Arts	3410	936
Pure science	1723	254
Medicine	2586	62
Engineering	1015	43
Technology	735	22
Agriculture	162	63
Other departments	203	11

To make the above summary more explicit, it should be pointed out that under "Arts," fine art, music, law, commerce, teachers' diploma, and economics are included; "Engineering" covers naval architecture; "Technology" comprises also mining, metallurgy, and architecture; and "Agriculture" embraces horticulture and dairy-work.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. N. Cunliffe, of Trinity College, has been appointed to the office of assistant to the superintendent of the museum of zoology for one year as from October 1.

The Board of Agricultural Studies reports that the number of students receiving instruction in the School of Agriculture continues to increase. This term 117 names are on the books, as compared with 106, 100, and 81 in the corresponding terms of the last three years. It is hoped that the new building will be ready for occupation in October, 1913. The rooms lately vacated by the Forestry Department are now used for the advisory work subsidised by the Development Commissioners. In addition to the University farm, possession of How House Farm for the purposes of the Plant Breeding Institute was taken on September 30. The farm belongs to Trinity College, and consists of 146 acres of arable land and 67 of pasture. The soil survey of the eastern counties is in active progress. The analytical work on the soils of Norfolk, Cambridgeshire, Isle of Ely, and Huntingdonshire is completed, and that of Bedfordshire, Suffolk, and Northamptonshire is well in hand.

OXFORD.—On November 19 the decree assigning a plot of land on the south side of the University park for an extension of the chemical department was proposed by the president of Magdalen, opposed by Prof. Oman, and carried in Convocation by 175 to 106. In the same Convocation, a decree assigning a plot at the north-west corner of the park for the erection of an engineering laboratory, also proposed by the president of Magdalen, was supported by Prof. Jenkin, opposed by the rector of Exeter, and rejected by 234 to 81. The vote may be taken, not as showing any ill-will on the part of the University to the subject of engineering, but as the expression of a pretty general opinion that a more suitable site than that suggested could be found for the proposed laboratory.

THE Right Hon. Sir Albert Spicer, Bart., M.P., will distribute the prizes and certificates at the Borough Polytechnic Institute, Borough Road, London, S.E., on Monday, December 2, at 8 p.m.

IT is proposed to establish at the Huddersfield Technical College a library relating to the woollen and worsted industries, to include (1) pamphlets, books, and printed matter of all kinds, and (2) pictures and other illustrations dealing with the rise and growth of the industries, their present position and possible further developments. An appeal is made, therefore, for gifts of books, &c., and for donations of money with which to purchase necessary additions to the library not otherwise obtainable. Any contributions may be sent to the secretary, Technical College, Huddersfield.

IN her lecture on November 15 to the London Child Study Society on Maria Montessori's method and self-education, Madame Pujol-Ségalas urged that from different points of view Froebel and Montessori perceive the same necessity for taking "nature as a guide" in the endeavour to create conditions favourable to the child's development. Attempts, she said, have been made in Europe and America to apply natural and rational methods in practical teaching, but the teachers experience difficulties from a deformation of the child's mind which has previously taken place. Such deformation does not take place in the houses administered under the Montessori system, because the training is as a rule individual instead of being constantly collective, and because it leaves room for the free expansion of the growing life. The aim of the system is to show how it is possible to stop making slaves of our pupils, intellectually and morally. Montessori schools are laboratories of experimental psychology in the truest sense. Practical difficulties in the application of the method vary together with qualities of races, classes, persons, and age. In order to serve the children we must have faith in human nature, and give it an opportunity of rising up to its highest present ideal, so that realising it, it may conceive new ones, higher still, ever progressing, and thus fulfilling its destiny.

AN interesting point made in the preface to the recently published calendar of the University College of North Wales for the session 1912–13 is that to the establishment of the college all classes of the community contributed their aid with remarkable unanimity. Never before, in so short a period, had so many persons, either in England or in Wales, subscribed towards a movement for the promotion of higher education. The subscription list was opened at a meeting held in Chester on January 23, 1883, when seven gentlemen subscribed 1000*l*. each. In twelve months the list had risen to upwards of 30,000*l*., the total number of subscribers being nearly 8000. A large proportion of this amount was given in small sums, much of it as the result of a house-to-house canvass in the rural parts of North Wales. More than 1250*l*. was contributed by the quarrymen of the Penrhyn and Dinorwic Quarries, who undertook the entire work of collection, appointing collectors for each "gallery" in the quarry and contributing each monthly pay-day a fixed sum out of their earnings. In view of this local enthusiasm for higher education, it is not surprising that there should have been a progressive increase in the number of students year by year. At the beginning of the session 1884–5, the total number of students was fifty-eight, while the session 1911–12 opened with 338 students, three-quarters of whom were from North Wales.

IN the issue of *Science* for October 25 last, Prof. Rudolf Tombo, Junior, of Columbia University, contributes an article on the geographical distribution of the student body of a number of American universities and colleges. Among other matters of interest, Prof. Tombo deals with the number of foreign students at American institutions of higher learning. Thirty-seven American universities and colleges together attracted no fewer than 1782 foreigners during the academic year 1910–11, exclusive of the attendance at summer courses. Of these students from other countries, Canada sent 344, China 330, Japan 197, Mexico 193, Turkey (in Europe and Asia) 84, India 73, British Isles 72, Cuba 62, Germany 48, Russia 48, and Australia 47. When the foreign *clientèle* of twenty-one of the leading American universities is compared with that of the twenty-one German universities, America is seen to be far behind Germany in attracting foreign students to its institutions of higher learning. During the winter session of 1910–11 the German universities were attended by no fewer than 4672 foreign students, as against 1576 foreigners at the American universities mentioned. The German universities draw 4046 students from other European countries, 398 from North and South America, 203 from Asia, 20 from Africa, and 5 from Australasia, while the American universities attract 478 students from North American countries outside of the United States, 112 from South America, 318 from Europe, 587 from Asia, 32 from Africa, and 49 from Australasia; in other words, the American universities lead in every continent with the exception of Europe.

THE Imperial Education Conference, at its meeting last year, recommended that there should be appointed in connection with that conference an advisory committee consisting of the accredited agents in London of the several Governments concerned, together with representatives of the Colonial Office, the India Office, the Board of Education, the Scotch Education Department, and the Irish Office. The functions of the committee as recommended by the conference were to be to keep itself acquainted with the progress of any courses of action that the conference had recommended, to facilitate that progress when necessary by communicating with the Governments concerned, and to consider such proposals as might be submitted for the agenda of any future meetings of the conference. The following representatives have been nominated by the various Governments and departments concerned to serve on the committee: Mr. L. A. Selby-Bigge, C.B., Board of Education; Dr. H. Frank Heath, C.B., Board of Education; Sir John Struthers, K.C.B., Scotch Education Department; Dr. W. J. M. Starkie, Irish Government; Sir H. W. Just, K.C.M.G., Colonial Office (Dominions Division); Mr. J. F. N. Green, Colonial Office (Crown Colonies); Sir Theodore Morison, K.C.I.E., India Office; the Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., Dominion of Canada; the Right Hon. Sir G. H. Reid, P.C., G.C.M.G., Commonwealth of Australia; the Hon. Thomas Mackenzie, Dominion of New Zealand; Mr. T. Slingsby Nightingale, Union of South Africa; Mr. T. A. Coghlan, New South Wales; the Hon. Sir John Taverner, Victoria; Major Sir Thomas Robinson, Queensland; the Hon. A. A. Kirkpatrick, South Australia; Mr. Cyril Jackson, Western Australia; the Hon. Sir John McCall, Tasmania. The Board of Education has placed at the disposal of the committee the services of Mr. W. W. Hornell, Assistant Director of Special Inquiries and Reports, to act as honorary secretary.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 7.—Sir Archibald Geikie, K.C.B., president, in the chair.—Louis V. **King**: The scattering and absorption of light in gaseous media, with applications to the intensity of sky radiation. The analysis of the present investigations seems to support the view that, at levels above Mount Wilson, molecular scattering is sufficient to account completely both for attenuation of solar radiation and for the intensity and quality of sky radiation. Even at sea-level the effect of "atmospheric dust" can be taken into account in a simple manner in formulæ for absorption and scattering.—Dr. P. E. **Shaw**: A standard measuring machine.—E. M. **Stubbs** and Dr. E. B. R. **Prideaux**: A spectro-photometric comparison of the emissivity of solid and liquid gold at high temperatures with that of a full radiator. (1) The emissivity of solid and liquid gold at high temperatures, relative to the emissivity of a full radiator at the same temperatures, has been measured throughout the visible spectrum. (2) A sharp discontinuity in the emissivity takes place at the melting point, the liquid gold emitting more strongly than the solid in the red and yellow, and less in the extreme blue. The shape of the "relative emissivity" curves is quite different in the two cases. (3) The curve of "relative emissivity" of solid gold at high temperatures is similar to that of absorptivity at low temperatures as determined from reflectivity measurements; whether it is identical, in which case the temperature coefficient of the absorptivity would be *nil*, could not be absolutely determined, owing to the change of structure which a polished surface undergoes on heating. (4) No temperature coefficient of "relative emissivity" could be detected for the liquid metal through a range of more than 100°. (5) "Black body" temperatures of solid and liquid gold at the melting point have been calculated. (6) It has been shown that the general equation expressing the radiation of a selective radiator is of the form

$$E_{\lambda'} = f(\lambda, T) c_1 \lambda^{-5} e^{-c_2/\lambda T},$$

which in the case of gold and other metals cannot be reduced to the form of Wien's equation for a full radiator with changed values of the constants.—C. **Smith**: Optical properties of substances at the critical point.—Hon. R. J. **Strutt**: Absorption of helium and other gases under the electric discharge. Attempts to repeat Berthelot's absorption of helium by carbon disulphide under the influence of the silent discharge have given absolutely negative results. Helium is slightly absorbed by phosphorus under electric discharge, though in much less quantity than nitrogen or hydrogen. The absorption in the former case is regarded as mechanical, in the latter as chemical.—F. W. **Aston**: The discharge between concentric cylinders in gases at low pressures. (1) The relations between pressure, voltage, and the length of the Crookes dark space in the discharge between concentric cylinders take much the same form as those in the discharge between parallel planes. (2) Curvature of the surface of the kathode appears to have no influence upon the rate of alteration of the length of the dark space with change of current density, *so long as the latter is measured at the surface of the kathode.* (3) *Ceteris paribus*, the length of the dark space is greater for a convex cylindrical surface than a plane, and for a plane than a concave one.—F. W. **Aston**: The influence of the nature of the kathode on the length of the Crookes dark space. (1) The relations between the values of pressure, voltage, current, and the length of the dark space are determined for plane kathodes of many different materials, and found to satisfy the same form of equations as those previously given for aluminium, the constants varying considerably. (2) Roughness of the kathode surface does not appear to affect the discharge, if the dimensions of the irregularities are small compared with the length of the dark space. (3) The length of the dark space is shown, in the cases examined, to be greatest for silver and least for magnesium, the metals following the same order as in the case of the kathode fall. (4) The rate of change of length of the dark space with change of current density at the surface of the kathode seems much the same for all kathodes. (5) Difficulties in the way of arriving at a satisfactory explanation of these and other data connected with the dark space are indicated and shortly discussed.—A. **Campbell**: The determination of the absolute unit of resistance by alternating-current methods.—A. **Mallock**: Some unclassified properties of solids and liquids. This paper suggests that many qualities of solids and liquids, which, although well known and commonly recognised, are not classified (qualities, for instance, such as ductility and malleability), may be explained by reference to the relations of the limits of the principal elasticities of the substances. A real homogeneous isotropic substance, whether solid or liquid, offers two distinct kinds of resistance to deformation, viz., resistance to alteration of volume and resistance to shear. There are also two distinct and different limits to each of these kinds of deformation—limits which cannot be exceeded without causing rupture or permanent alteration of the substance. When a strain involves both shear and alteration of volume, the behaviour and properties of the strained material depend to a great extent on whether the limit of shear or the limit of volume alteration is the first to be overcome.—Sir W. de W. **Abney**: Trichromatic theory of colour vision. The measurement of fatigue of the retina.

November 14.—Sir Archibald Geikie, K.C.B., president, in the chair.—J. W. **Cropper**: The development of a parasite of earthworms. A description of "bodies" found within some of the epithelial cells of the vesiculæ seminales of the earthworm. They closely resemble "Kurloff's bodies" found within the lymphocytes of guinea-pigs. By means of the jelly method of examination, the development of these bodies into free spirochætes is demonstrated in the same way that it has recently been shown that "Kurloff's bodies" also become spirochætes. The author suggests that these new parasites be called *Spirochaeta lumbrici*.—Edith R. **Saunders**: Further contribution to the study of the inheritance of hoariness in stocks (Matthiola).—Prof. A. J. **Brown** and F. P. **Worley**: The influence of temperature on the absorption of water by seeds of *Hordeum vulgare* in relation to the temperature coefficient of chemical change.—R. **Kirkpatrick**: Note on *Merlia normani* and the "Monticuliporas."—James **Thompson**: The chemical action of *Bacillus cloacae* (Jordan) on citric and malic acids in the presence and absence of oxygen.—G. W. **Ellis** and J. A. **Gardner**: The origin and destiny of cholesterol in the animal organism. Part x., The excretion of cholesterol by man, when fed on various diets.—Prof. R. Boyd **Thomson**: The comparative anatomy and affinities of the Araucarineæ.—Muriel **Robertson**: Notes on the polymorphism of *Trypanosoma gambiense* in the blood and its relation to the exogenous cycle in *Glossina palpalis*. H. L. **Duke**: Further observations on the recovery of *Trypanosoma gambiense* from *Tragelaphus spekei* on the islands of Lake Victoria Nyanza.—Colonel Sir David **Bruce**, Majors **Harvey** and **Hamerton**, Dr. J. B. **Davey**, and Lady **Bruce**: The morphology of *Trypanosoma simiae*, sp. nov.—H. L. **Duke**: (1) Some observations on *T. pecorum* (Bruce) and *T. uniforme* (Bruce). (2) A camel Trypanosome; with some remarks on the biometric method of diagnosing Trypanosomes. (3) Some experiments with arsenphenylglycin and *Trypanosoma gambiense* in *Glossina palpalis*.—Dr. H. **Bayon**: The cultivation of *Trypanosoma rhodesiense* (Stephens and Fantham).

Zoological Society, October 29.—Prof. E. A. Minchin, F.R.S., vice-president, in the chair.—Mrs. Rose Haig **Thomas**: Eggs of *Phasianus versicolor, P. formosus*, and of the F_1 and F_2 offspring of an experimental cross between a male *P. versicolor* and a female *P. formosus*. Attention was directed to the resemblance in size of the eggs of the offspring and of the male parent species, whereas the expectation was a likeness to those of *P. formosus*, thus showing the descent through the male to his female offspring of the small egg of his species.—E. G. **Boulenger**: The breeding-habits of the "Millions" fish (*Girardinus poeciloides*). Cases were recorded of the male of this species breeding before assuming the livery of its sex. The author directed attention to parallel cases among fishes, in which, however, except in one case, the question was one of degree only.—Rev. T. R. R. **Stebbing** read a paper on the crustacea Isopoda of the *Porcupine* expedition.—Dr. F. E. **Beddard**: The anatomy and sytematic arrangement of the Cestoidea.—E. Dukinfield **Jones**: Thirteen new species of butterflies of the genus Thecla, collected at various localities in south-east Brazil.

Challenger Society, October 30.—Prof. E. W. MacBride in the chair.—D. J. **Matthews**: (1) A bacteriological water-bottle. This bottle consists essentially of a glass-lined brass cylinder, closed at each end by rubber washers. It is lowered closed and full of alcohol, sterility being thus ensured and external pressure counteracted; it is then opened (when sea-water replaces the alcohol) and closed by messengers. (2) The observations of Mr. G. H. Drew in the Tongue of the Ocean. The Tongue is an inlet of deep water (700 to 1000 fathoms) running southward into the Great Bahama Bank. The salinity and temperature in the depths agreed with those of nearest stations of *Challenger* and *Michael Sars*; surface temperatures were higher. A layer of water of high salinity was found near the surface near the coast, but not farther out, and as it was not accompanied by irregularities of the temperature curve, a strong current was probable.—E. **Heron-Allen** and A. **Earland**: *Saccammina sphaerica* (M. Sars) and *Psammosphaera fusca* (Schulze). The views of Dr. Ludwig Rhümbler as to the life-history of these forms were combated, and the stages of the life-cycle he described referred to different species, namely *Crithionina mammilla* (Goes) and the above. The three species were found to differ widely in distribution, though they sometimes occur together.

Geological Society, November 6.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—Prof. A. C. **Seward**: A contribution to our knowledge of Wealden floras, with special reference to a collection of plants from Sussex. In this paper an account is given of specimens of Wealden plants from the Sussex coast, for the most part from the neighbourhood of Fairlight, acquired by the British Museum since 1895, the date of publication of the second part of the Wealden Flora (British Museum catalogue).—E. **Proctor**: Notes on the discovery of fossiliferous Old Red Sandstone in a boring at Southall, near Ealing. With a note on the fish-remains, by Dr. A. Smith **Woodward**. The boring described in this paper is situated at Southall, and was made for the purpose of obtaining water from the Lower Greensand. For this purpose, however, the boring was a complete failure, as it passed directly from the Gault into Palæozoic rocks. The older rocks were met with at a depth of 1130 ft., and continued with slight variation to a depth of 1261 ft., the lower limit of the borehole. The fossils were yielded by definite bands, which varied from 1 in. to an eighth of an inch in thickness; they consisted mainly of scales and teeth of Holoptychius and plates of Bothriolepis, both characteristic genera of the Old Red Sandstone.

Linnean Society, November 7.—Prof. E. B. Poulton, president, in the chair.—Dr. R. R. **Gates**: Mutating Oenotheras. The following facts and views regarding mutation as an evolutionary factor were referred to:—(1) *Oenothera Lamarckiana* has probably undergone crossing in the wild state to the same extent that other open pollinated species intercross. (2) The mutation phenomena are an evidence of germinal instability resulting from crossing, change of climate, or cultivation. (3) Hybrid splitting is inadequate to account for the forms which suddenly appear. (4) Some of the mutants differ from the parent in their physiological adjustments, and this may account for cases of "climatic adaptation," but mutations will not suffice to explain the more complex adaptations which involve inter-relationships between several organisms. (5) *O. rubricalyx* has originated as a heterozygous mutant, but there are obvious difficulties in applying the same explanation to the other mutants of Oenothera. (6) The origin of certain of the mutations, at least (*e.g. O. lata, O. gigas*), is intimately concerned with chromosome mechanisms; that of certain others may be concerned with the action of releasing stimuli. (7) Darwinian natural selection always assumed an original environmental change for the organism, either (*a*) a change of climate in a given area, or (*b*) the introduction of new organisms, leading to the gradual modification of the species. (8) But neither chance-wise mutations in all directions nor the vicissitudes of changing climates and distributions can account for the orderly phylogenies which larger groups of organisms frequently show. (9) There is no single evolutionary factor, but the process is a multifarious one.—H. N. **Ridley**: A collection of plants from Mount Menuang Gasing, Selangor. In February, 1912, Mr. C. B. Kloss made an expedition to Mt. Menuang Gasing in Selangor to collect the fauna and flora of this mountain. In this paper is an account of the expedition and of the plants collected by him in four or five days spent at an altitude of 4900 ft. there. Menuang Gasing is the most southern high point of the great chain of the granite mountains which form the backbone of the peninsula, and the object of the expedition was to discover whether the high mountain fauna and flora descended so far south as this point. The mountain is 4900 ft. high, and though there are other hills a little south of this, this is the highest and most likely to bear the high hill flora. The fauna was found to belong to that of high northern ranges, and the flora shows clearly that it corresponds. Among the characteristic plants found were the golden balsam, *Impatiens oncidioides*, Ridl., *Bucklandia populnea*, R. Br., the rare *Polyosma parviflora*, King, *Pratia begonifolia*, Lindl., *Dilochia Cantleyi*, Ridl., and *Goodyera gracilis*, Hook. fil. The only mountain south of this one of approximate altitude is Mt. Ophir in Malacca; the flora of this is well known, and is very different from that of the main range. Indeed, there is every evidence that Mt. Ophir was never connected with the main chain, at least during the period of the evolution of the flora. One hundred and forty-three species were collected by Mr. Kloss, of which fourteen were undescribed; of these the most noteworthy were what is probably the biggest species of the large genus Oberonia, a remarkable species of Blastus, and a new species of Balanophora.

Mathematical Society, November 14.—Annual meeting.—Dr. H. F. Baker (president, 1910–11), and afterwards Prof. A. E. H. Love (the newly elected president), in the chair. After the election of council and officers for the coming session, the following papers were communicated:—A. B. **Grieve**: Some properties of cubic surfaces.—Prof. W. H. **Young**: The determination of the summability of a function by means of its Fourier constants.—Prof. W. **Burnside**: Groups of linear substitutions which possess quadratic invariants.—J. B. **Holt**: The irreducibility of Legendre's polynomials.—Prof. E. W. **Hobson**: The representation of a summable function by means of a series of finite polynomials.—E. **Cunningham**: Theory of functions of a real vector.—G. N. **Watson**: Some solutions of Laplace's equation.

PARIS.

Academy of Sciences, November 11.—M. Lippmann in the chair.—Edouard **Branly**: The intermittent conductivity of thin dielectric layers. An experimental study of the electrical conductivity of thin sheets of dielectrics (gutta-percha, collodion, mica, celluloid, varnish) under varying conditions of pressure and electromotive force, and submitted to the effects of shock or induced oscillatory currents set up at a distance by the spark discharge of a condenser. The results are applied to explain the action of radio-conductors utilised in wireless telegraphy.—M. **Borrelly**: Observations of the Borrelly comet (1912*c*) made at the Observatory of Marseilles with the comet-finder. Positions are given for November 3, 6, and 8.—M. **Coggia**: Observations of the Borrelly comet (*c*, November 2, 1912) made at the Observatory of Marseilles with the 26 cm. Eichens equatorial. Positions given for November 4 and 8.—M. **Giacobini**: Observations of the new Borrelly comet (1912*c*) made at the Paris Observatory with the 40 cm. equatorial. Positions given for November 6 and 7.—J. **Guillaume**: Observations of the Schaumasse comet (1912*b*) made at the Observatory of Lyons. Positions given for October 2, 3, 6, and 7.—MM. **Luizet** and **Guillaume**: Observations of the Borrelly comet (1912*c*) made at the Observatory of Lyons. Six positions given for November 7, 8, and 9.—P. **Chofardet**: Observations of the Borrelly comet made at the Besançon Observatory. Five positions given for November 4, 6, and 7.—P. **Brück**: Observations and elements of the Borrelly comet (1912*c*) obtained at the Observatory of Besançon.—Louis **Fabry**: The identification of the small planets.—Jean **Chazy**: A differential system formed by M. Schlesinger.—Ch. J. de la Vallée **Poussin**: The development of trigonometrical series.—M. **Hisely**: A new theorem on the effects of moments.—M. **Poincet**: The wake and suction at the back of ships. A discussion of the results of experiments carried out by Creusot on the torpedo-destroyer *ST*, and their bearing on the propulsion of turbine vessels.—M. **Duchêne**: The use of the carrying planes in the construction of an aëroplane.—Alphonse **Berget**: A velocity formula applicable to aëroplanes. An empirical formula, $V = A\left(\frac{F}{S}\right)^{\frac{1}{3}}$, is given, in which V is the velocity, S the supporting surface of the planes, F the h.p. of the motor, and A a numerical coefficient. In eleven types of aëroplane actually in use the coefficient A varies between 7 and 8.—C. **Raveau**: The fringes of holohedral crystalline plates with parallel faces.—Georges **Claude**: The phenomena of electrical pseudo-resonance.—M. **Hanriot**: Drawing down metals.—L. **Grimbert** and M. **Laudat**: The estimation of lipoids in blood serum. A description of a rapid and moderately accurate method of determining cholesterol, lipoids containing phosphorus, fatty acids, and neutral fats in a small quantity of blood serum. Analytical figures are given for normal and pathogenic serum.—H. **Vincent**: The diagnosis of typhoid fever by the spleen reaction. The injection of a preparation made from typhoid bacilli determines a characteristic hypertrophy of the spleen in cases of typhoid fever, and this reaction appears to be specific. It has given positive results in cases where the blood culture remained sterile.—Léon **Bernard**, A. Le **Play**, and Ch. **Mantoux**: The minimum pulmonary capacity compatible with life.—C. **Schlegel**: The influence of temperature on the course of development of *Maïa squinado*.—Henri **Martin**: The distribution of the human deposits in the Mousterian layer of La Quina (Charente).—Léon **Bertrand** and Louis **Mengaud**: The structure of the Cantabrian Pyrenees, and their probable relations with the western Pyrenees.—G. **Vasseur**: The discovery of a layer of vertebrates in the upper Agenais Aquitanian. The geological age of the fauna of Saint-Gérand-le-Puy.

BOOKS RECEIVED.

Der Kautschuk: Eine kolloid-chemische Monographie. By Dr. R. Ditmar. Pp. viii + 140 + plate. (Berlin: J. Springer.) 6 marks.

Elektrobiologie: die Lehre von den elektrischen Vorgängen im Organismus auf moderner Grundlage dargestellt. By Prof. J. Bernstein. Pp. ix + 215. (Braunschweig: F. Vieweg und Sohn.) 6 marks.

The Electrical Conductivity, Dissociation, and Temperature Coefficients of Conductivity from Zero to Sixty-five Degrees of Aqueous Solutions of a Number of Salts and Organic Acids. By Prof. H. C. Jones and others. Pp. iv + 148. (Washington: Carnegie Institution.)

Easter Island. The Rapanui Speech and the Peopling of South-east Polynesia. By W. Churchill. Pp. iv+340. (Washington: Carnegie Institution.)

The Mineralogy of the Rarer Metals. By E. Cahen and W. O. Wootton. Pp. xxviii+211. (London: C. Griffin and Co., Ltd.) 6*s*. net.

The Gas Turbine. Theory, Construction, and Records of the Results obtained from two actual Machines. By A. Holzwarth, translated by A. P. Chalkley. Pp. viii+140. (London: C. Griffin and Co., Ltd.) 7*s*. 6*d*. net.

Electrical Photometry and Illumination. By Prof. H. Bohle. Pp. xi+222. (London: C. Griffin and Co., Ltd.) 10*s*. 6*d*. net.

Science and the Human Mind. By W. . D. and C. D. Whetham. Pp. xi+304. (London Longmans and Co.) 5*s*. net.

Aeronautics. Technical Report of the Advisory Committee for the Year 1911–12. Pp. 323+plates. (London: H.M. Stationery Office; Wyman and Sons, Ltd.) 11*s*.

Collected Papers in Physics and Engineering. By Prof. J. Thomson. Selected and arranged with unpublished material and brief annotations by Sir J. Larmor and J. Thomson. Pp. civ+484. (Cambridge University Press.) 15*s*. net.

Papers on Psycho-Analysis. By Prof. E. Jones. Pp. xv+432. (London: Baillière, Tindall and Cox.) 10*s*. 6*d*. net.

The Lost Towns of the Yorkshire Coast, and other Chapters bearing upon the Geography of the District. By T. Sheppard. Pp. xviii+329. (London: A. Brown and Sons, Ltd.) 7*s*. 6*d*. net.

Notes and Queries on Anthropology. Edited by B. Freire-Marreco and Prof. J. L. Myres. Fourth edition. Pp. xii+288. (London: Royal Anthropological Institute.) 5*s*.

Zum Problem der Vererbungsträger. By Dr. F. Vejdovský. Pp. iii+184+12 plates. (Prag: Königl. Böhm. Gesellschaft der Wissenschaften.)

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 21.

ROYAL SOCIETY, at 4.30.—An Investigation of the Spectrum of Ionium: A. S. Russell and R. Rossi.—(1) A Note on the Absorption of β Rays; (2) The Similarity in Nature of X and Primary γ Rays: J. Gray.—The Spectra of Fluorescent Röntgen Radiations: J. C. Chapman.—Optical Investigation of Solidified Gases. II. The Crystallographic Properties of Hydrogen and Oxygen: Dr. W. Wahl.—An Electric Furnace for Experiments *in vacuo* at Temperatures up to 1500° C.: R. E. Slade.—An Investigation of the Dissociation-Pressures and Melting Points of the System Copper, Cuprous Oxide: R. E. Slade and F. D. Farrow.—Note on the Capacity Coefficient of Spheres: Dr. A. Russell.—The Motion of Viscous Liquid due to Uniform and Periodic Motion maintained over a Segment of an Infinite Plane Boundary: W. J. Harrison.—The Elastic Hysteresis of Steel: Prof. B. Hopkinson and G. T. Williams.—Ionic Size in Relation to Molecular Physics, together with a New Law relating to the Heats of Formation of Solid, Liquid and Ionic Molecules: W. R. Bousfield.—The Synthesis of a Silicalcyanide and of a Felspar: Dr. J. E. Reynolds.—A Method of Finding the Conductivity for Heat: Prof. C. Niven and A. E. M. Geddes.

INSTITUTION OF MINING AND METALLURGY, at 8.

LINNEAN SOCIETY, at 8.—Mr. P. A. Talbot's Collection of Plants from Southern Nigeria, illustrated by Lantern Slides: Dr. A. B. Rendle.—Impressions of the Feeding Tracks of *Limax maximus* and *Helix aspersa*: Mrs. Longstaff. Vegetable Mechanics: Rev. George Henslow. Some Indian Jurassic Gymnosperms: Miss Nellie Bancroft.

FRIDAY, NOVEMBER 22.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Vapour-Compression Refrigerating Machines: J. Wemyss Anderson.—A Contribution to the Theory of Refrigerating Machines: Dr. J. H. Grindley.

PHYSICAL SOCIETY, at 5.—(1) The Law of Plastic Flow of a Ductile Material; (2) Kinematograph Illustrations of the Torsion and Breaking of Large Specimens: C. E. Larard.—A Column Testing Machine: Prof. E. G. Coker.

MONDAY, NOVEMBER 25.

INSTITUTE OF ACTUARIES, at 5.—Inaugural Address by the President (Fredk. Schooling).

TUESDAY, NOVEMBER 26.

ROYAL SOCIETY OF ARTS, at 4.30.—The Hardwood Timbers of New South Wales: W. H. Warren.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Some Bronze Age and British Bones from Broadstairs, with Type Contours of all the Bronze Age Skulls in the Royal College of Surgeons Museum: F. G. Parsons.

ZOOLOGICAL SOCIETY, at 8.30.—The Genus Engæus, or the Land Crayfishes of Australia: G. W. Smith and Dr. E. H. J. Schuster.—The Structure of Bone in Fishes: a Contribution to Palæohistology: E. S. Goodrich.—Report on the Myzostomida collected by Mr. Cyril Crossland in the Red Sea in 1905: Dr. C. L. Boulenger.—Description of an Amphipod belonging to the Family Talitridæ, from the Woodbush, Transvaal: Hon. Paul A. Methuen.—Some Points in the Anatomy of the Mouth-parts of the Mallophaga: Bruce F. Cummings.

INSTITUTION OF CIVIL ENGINEERS, at 8 p.m.—Mechanical Handling of Coal for British Locomotives: C. J. B. Cooke.

FARADAY SOCIETY, at 8.—The Billiter Alkali-Chlorine Cells: Dr. A. J. Allmand.—A Neutral Oil Emulsion as a Model of a Suspension Colloid: R. Ellis.—Note on the Electrolysis of Nitric Acid Solutions of Copper: J. H. Stansbie.

WEDNESDAY, NOVEMBER 27.

ROYAL SOCIETY OF ARTS, at 8.—Political Economy as a Code of Life: H. Cox.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.—The Astronomical Significance of the Prehistoric Monuments in the Outer Hebrides: Capt. Boyle Somerville, R.N. *And other Papers.*

THURSDAY, NOVEMBER 28.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

CONCRETE INSTITUTE, at 7.30.—Bills of Quantities for Reinforced Concrete Work: John M. Theobald.

SATURDAY, NOVEMBER 30.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Some Letters from the Rev. Wm. Derham, Rector of Upminster, Essex, to Dacre Barrett, of Belhus, Essex (1704–1710). Communicated, with Remarks, by T. Barrett-Lennard.—The Mycetozoa: Miss Gulielma Lister.

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

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Registered as a Newspaper at the General Post Office.]

UNIVERSITY OF LONDON.

NOTICE IS HEREBY GIVEN that the Senate will shortly proceed to elect Examiners in the following subjects for the year 1913–14:—

HIGHER EXAMINATIONS FOR MEDICAL DEGREES.

EXAMINERSHIPS.	PRESENT EXAMINERS.
Four in *Medicine*	Sidney Philip Phillips, Esq., M.D., F.R.C.P. Humphry Davy Rolleston, Esq., M.A., M.D., B.C., F.R.C.P. W. B. Warrington, Esq., M.D., Ch.B., F.R.C.P. Vacant.
Four in *Surgery*	Frédéric F. Burghard, Esq., M.D., M.S., F.R.C.S. Raymond Johnson, Esq., M.B., B.S., F.R.C.S. Henry Betham Robinson, Esq., M.D., M.S., F.R.C.S. Vacant.
Two in *Forensic Medicine* and *Hygiene*	William A. Brend, Esq., M.A., M.B., B.Sc. Vacant.
Two in *State Medicine*	John William Henry Eyre, Esq., M.D., M.S., D.P.H. Vacant.

FIRST EXAMINATION AND SECOND EXAMINATION PART I., FOR MEDICAL DEGREES.

(Candidates for these Examinerships should be experienced in Teaching Medical Students.)

Two in *General Biology*	Vacant. Vacant.
Two in *Chemistry*	James Ernest Marsh, Esq., M.A., F.R.S. Vacant.
Two in *Physics*	George William Clarkson Kaye, Esq., D.Sc., B.A. Vacant.

SECOND EXAMINATION PART II., FOR MEDICAL DEGREES.

Two in *Anatomy*	Prof. A. Melville Paterson, M.D., M.S., F.R.C.S. Vacant.
Two in *Pharmacology*	Vacant. Vacant.
Two in *Physiology*	Joseph Barcroft, Esq., B.Sc., M.A., F.R.S. Vacant.

The Examiners above named are re-eligible, and intend to offer themselves for re-election.

Full particulars of the remuneration of each Examinership can be obtained on application to the Principal.

N.B.—Attention is drawn to the provision of Statute 124, whereby the Senate is required, if practicable, to appoint at least one Examiner who is not a Teacher of the University.

Candidates must send in their names to the Principal, with any attestation of their qualifications they may think desirable, on or before MONDAY, DECEMBER 16th. (It is particularly desired by the Senate that no application of any kind be made to its individual Members.)

If testimonials are submitted, three copies at least of each should be sent. Original testimonials should not be forwarded in any case. If more than one Examinership is applied for, a separate complete application, with copies of testimonials, if any, must be forwarded in respect of each.

University of London,
South Kensington, S.W.,
November, 1912.

By Order of the Senate,
HENRY A. MIERS,
Principal.

GOVERNMENT GRANT FOR SCIENTIFIC INVESTIGATIONS.

—Applications for the year 1913 must be received at the offices of the Royal Society not later than January 1 next, and must be made upon printed forms to be obtained from the Clerk to the Government Grant Committee, Royal Society, Burlington House, London, W.

ROYAL HOLLOWAY COLLEGE.

ENGLEFIELD GREEN, SURREY.

(University of London).

The Governors will award, early in December, three Post-Graduate Studentships for research or advanced work open to Graduates of the College. Applications should be made not later than December 2 to the PRINCIPAL, from whom full particulars may be obtained.

THE MURDOCH TRUST.

For the benefit of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

Donations or Pensions may be granted to persons who comply with these conditions.

For particulars apply to Messrs. J. & J. TURNBULL, W.S., 58 Frederick Street, Edinburgh.

SWINEY LECTURES ON GEOLOGY, 1912-13.

UNDER THE DIRECTION OF THE TRUSTEES OF THE BRITISH MUSEUM.

A Course of Twelve Lectures on "THE RECORD OF LIFE AS REVEALED IN THE ROCKS" will be delivered by T. J. JEHU, M.A., M.D., F.R.S.E., in the Lecture Theatre of the Victoria and Albert Museum, South Kensington (by permission of the Board of Education), on Mondays, Thursdays and Saturdays, at 3 p.m., from Saturday, December 7, to Saturday, December 21 (inclusive), and from Saturday, January 4, to Monday, January 13 (inclusive). The Lectures will be illustrated by Lantern Slides. Admission FREE. Entrance in Exhibition Road.

By Order of the Trustees,
L. FLETCHER, Director.

British Museum (Natural History),
Cromwell Road, London, S.W.

CHEMICAL SOCIETY RESEARCH FUND.

A Meeting of the Research Fund Committee will be held in December next. Applications for grants, to be made on forms which can be obtained from the Assistant Secretary, must be received on or before Monday, December 2, 1912.

All persons who received grants in December, 1911, or in December of any previous year, whose accounts have not been declared closed by the Council, are reminded that reports must be in the hands of the Hon. Secretaries not later than Monday, December 2.

The Council wish to draw attention to the fact that the income arising from the donation of the Worshipful Company of Goldsmiths is to be more or less especially devoted to the encouragement of research in inorganic and metallurgical chemistry. Furthermore, that the income due to the sum accruing from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal-tar and allied industries.

ESSEX EDUCATION COMMITTEE.

EAST ANGLIAN INSTITUTE OF AGRICULTURE, CHELMSFORD.

CHIEF ANALYST AND LECTURER IN AGRICULTURAL CHEMISTRY.

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A. MALINS SMITH, Principal.

East Anglian Institute of Agriculture,
Chelmsford,
November 15, 1912.

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Poincaré

THURSDAY, NOVEMBER 28, 1912.

SCIENTIFIC WORTHIES.

XXXIX.—Prof. Jules Henri Poincaré, For. Mem. R.S.

It has only happened on one or two occasions that the subject of an article in our series of Scientific Worthies has had to be referred to in the past tense; and we deplore that such should be the case now. Many men of science continued to make important additions to the monument of natural knowledge long after contemporary contributors to this series had paid tribute to their achievements, and fortunately some are still with us. A testimony to good and faithful work has its interest vastly increased when it can be accompanied by the thought that past performances may be equalled, or even excelled, by future accomplishments. This satisfaction is denied us when *Finis* has to be written against a man's work; and though the coral-rock represented by it may be strong and beautiful, it lacks those qualities of activity and growth which were once manifest on its summit and are essential attributes of the scientific spirit.

A great man of science builds not so much for his own generation as for the generations which follow him. As M. Berthelot once said:—"If each of us adds something to the common domain in the field of science, of art, of morality, it is because a long series of generations have lived, worked, thought, and suffered before us." For workers of to-day and to-morrow M. Poincaré not only opened new fields, but pointed the way to discovery by those who follow him. Mathematics, physics, astronomy, philosophy, and other domains of intellectual activity have all been extended and illuminated by his genius. The search for truth was for him a passion, and all his work was animated by it. His "Science and Hypothesis" represents an examination into the solidity of the foundations upon which scientific reasoning is based. To the superficial reader the work may appear iconoclastic, but many of the images it destroys should never be set up in the temple of scientific belief; and if they cannot stand before the strong rays of relentless logic, science is better without them. For in nature

"Beauty is truth, truth beauty; that is all
Ye know on earth, and all ye need to know."

That such a brilliant and original thinker as M. Poincaré should have died, on July 17 last, at the relatively early age of fifty-eight is a cause of world-wide regret. It would take several articles to do justice to his work and scholarship, but we must here limit ourselves to appreciative mention of a few prominent points of a remarkable career.

M. Poincaré was born at Nancy on April 29, 1854, and commenced his studies at the Lycée there. He afterwards passed successively through l'École Polytechnique and l'École nationale supérieure des Mines, receiving his doctor's degree in mathematical sciences from the University of Paris in 1879. He then began his career as instructor in mathematical analysis at the University of Caen, from which position he was called in 1881 to occupy the chair of physical and experimental mechanics at the Sorbonne (University of Paris). Later he occupied the chair of mathematical physics, and, after the death of M. Tisserand, he passed to that of mathematical astronomy and celestial mechanics. M. Poincaré was elected a member of the Paris Academy of Sciences in 1887, and a member of the French Academy in 1908. He was president of the Academy of Sciences in 1906, and of the Bureau des Longitudes in 1899 and 1909. He was also an honorary member of most of the leading scientific societies of the world, and received honorary degrees from the Universities of Oxford, Cambridge, Glasgow, Christiania, Stockholm, and Brussels. In 1901 the first award of the Sylvester medal of the Royal Society was made to him in recognition of his many and important contributions to mathematical science.

The first volume of a series entitled "Savants du Jour," published in 1909 by Messrs. Gauthier-Villars, of Paris, is devoted to M. Poincaré, and it contains a list of more than four hundred of his publications relating to mathematical analysis, analytical and celestial mechanics, mathematical physics, and philosophy of science. But the value of Poincaré's work is not to be estimated merely by its bulk, although that is unusually large; he never wasted words or wrote on trifles, and his shortest notes, like those of Hermite, are always worth attention. Again, the range of his topics was very wide; arithmetic, probability, function-theory, dynamics, mathematical physics are all indebted to him for results of interest and often of the greatest importance. Finally, he had, in the highest degree, the gift of literary style; few of his scientific compatriots can rival him in directness, simplicity, and grace. There is a story that Clifford, during a walk with a friend, made him understand the gist of Abel's theorem; it is easy to imagine Poincaré, in similar circumstances, successfully expounding the nature of the Fuchsian functions.

Many must be able to recall the delight with which they read those famous memoirs in the early volumes of the *Acta Mathematica*, and the eagerness with which they turned to each new part, in the hope of finding more of this enchanting *causerie*. Few formulæ, and short ones at that; just a succession of brief, almost conversational, sentences opening up a new and vast domain in which even such a subject as elliptic modular functions took a place like that of reciprocants in the general theory of differential invariants; new vistas and new problems presenting themselves on every side. It is easy enough to trace the lineage of the automorphic functions. Immediately suggested by Fuchs's work on differential equations, and actually a generalisation of modular functions, they are historically the outcome of Gauss's memoir on the hypergeometric series, and Riemann's paper on the P-function. To say this is no detraction from Poincaré's merits: the fact is that, like Lejeune-Dirichlet, he won many of his highest triumphs by his extraordinary power of seizing the main points of an existent theory, simplifying it by an appropriate analysis, and then extending it beyond all expectation. Compare, for instance, the present positions of the theories of modular functions and of Fuchsian functions. In the former, apart from further application to arithmetic and the like, the one main problem that still remains is to find out, if possible, the arithmetical characters of all the sub-groups of the modular group; in the latter there are difficulties at the outset, arising from the fact that in certain families of Fuchsian groups there are conditions of inequality which involve troublesome relations connecting the constants of the generating substitutions. In this and in other matters Poincaré did not go into detail: but he pointed out the way for others by his distribution of the functions into families, and by his geometrical method with its non-Euclidean interpretation. Perhaps the crowning result of his work in this direction is his theorem that the coordinates of any point on an algebraic curve can be expressed as one-valued Fuchsian functions of a parameter. This is analogous to the representation of a point on a circle by $(\sin\theta, \cos\theta)$, and is to be distinguished from the Puiseux-Weierstrass representation of an element of the curve.

A more definite example of Poincaré's power of dealing with a classical problem is afforded by his work on rotating fluid masses. Long ago it was shown by Jacobi that an ellipsoid of three unequal axes was a possible figure of relative equilibrium: but it was reserved for Poincaré to take up the problem afresh, and develop the solution into what may fairly be called (apart from details) its final and definite form. He shows the existence of whole families of figures of equilibrium, including as particular cases those already known; gives analytical criteria for stability; and proves that when, by varying the parameter that generates a particular family, we pass from stability to instability, the critical surface is one of "bifurcation," that is, it simultaneously belongs to two distinct families. In some respects this is analogous to the way in which a curve $f(x, y, \mu)=0$, by variation of μ, acquires a double point, and then alters what may be called its connectivity; and in any case, without pressing the analogy, Poincaré's results here seem typical of what happens, with regard to stability, in the variation of dynamical systems. The value and originality of these researches was recognised by Sir G. H. Darwin in his address to the Royal Astronomical Society, when its gold medal was presented to Poincaré (Feb. 9, 1900).

The contributions of Poincaré to celestial mechanics not only brought new life to a subject which showed signs of becoming stale, but undoubtedly opened up a fresh line of investigation. Starting with an idea due to G. W. Hill, who, in his turn, was indebted to Euler, he brought the whole range of his great knowledge and power of analysis to bear on a problem which has baffled the ingenuity of mathematicians for more than two hundred years. That he did not succeed in solving it, either in the old or the modern sense, is no criticism on his achievements; it is sufficient to say that he opened the way and explored a new region by routes which may ultimately lead to the final goal—a demonstration of the stability or instability of the solar system.

His investigations on the general problem of three bodies are principally contained in the three volumes entitled "Les Méthodes Nouvelles de la Mécanique Céleste," which form a natural sequence to the earlier prize essay of 1889. The foundation of the work is the now well-known periodic solution of a set of differential equations. Hill had developed one such solution arising in the motion of the moon round the earth; Poincaré considers periodic solutions of any class of differential equations, examining their general properties and the conditions for their existence. He then takes up the special properties of the equations of dynamics and, descending still further into details, the applications to the problem of three bodies and to restricted cases of this problem. No general method for finding the solutions, nor for discovering the full number of them, is obtained, but these needs are being supplied by the researches of Darwin, Moulton and others into the possible orbits which may be described in various circumstances.

The periodic orbit only represents a particular solution of the equations of motion. Poincaré obtains a general solution within a limited range of the arbitrary constants by considering those differing slightly from the periodic solution. In this connection arise the "characteristic exponents" which may be somewhat loosely taken to give the various periods present in the general solution. These exponents form the bridge which enables him to enter into such questions as the existence of integrals, the analytic forms of possible solutions and the convergence or divergence of the series thus formed. His proof that there cannot exist any algebraic or transcendental integral of the problem of three bodies (under a restriction as to the magnitude of the masses) beyond those known is an important advance on Bruns' result—that no new algebraic integral exists, although the latter is true for any values of the masses.

Not less important is his examination of the older methods from the logical point of view. His presentation of these is nearly always fresh and novel; he is rarely content with previous methods of arriving at the results. This change is perhaps necessary, for he has a different object in view; nevertheless, the reading of them frequently gives the impression that Poincaré simply took the premises and the conclusions and found it less difficult to work out the latter from the former in his own way than to go fully into the author's work. Perhaps the most startling result was his discovery that the majority of the series which have been used to calculate the positions of the bodies of the solar system are divergent. This fact, of course, required an examination into the reasons why the divergent series gave sufficiently accurate results: hence arose the theory of asymptotic series now applied to the representation of many functions.

The crux of the problem is the divergent series. The functions are only represented in the numerical sense by series, and we do not know their limits. Can we argue one way or the other as to the stability of the system? In other words, is the ultimate divergence peculiar to the functions, or is it merely due to our inability to obtain expressions from which a conclusion can be deduced? The question remains unanswered. Gylden believed that he had overcome the difficulty, but Poincaré has shown that it still exists.

Whilst the greater part of Poincaré's researches are thus confined to the logical side of the problems in celestial mechanics, we have occasional papers in which he developed methods useful for actual calculation, in addition to those chapters of the "Méthodes Nouvelles" which are devoted to this part of the subject. Amongst them may be mentioned one on the lunar theory, in which he developed a method with rectangular coordinates which appears to be of value for obtaining algebraic expressions for the coordinates of the moon. There are also two papers dealing with librations in planetary systems which open a way to the more extensive treatment of this complex subject. They have received less notice on account of their narrower range of application; they are incorporated with other matter in his "Leçons de Mécanique Céleste." The recently published volume on cosmogony is of a different nature. It is chiefly a presentation, given originally in a course of lectures, of the works and theories of others, but he does not hesitate to express his own opinions as to their importance in a discussion of the evolution of solar and stellar systems.

A pure mathematician might be pardoned for doubting whether the world, as a whole, benefited by Poincaré's appointment to a chair of mathematical physics. The redactions of his early lectures on electricity and optics have to be read with a certain amount of reserve; he is not yet sure of his ground, and is assimilating the ideas of others. It is difficult to conjecture what he might have done if he had been able to follow up his original bent, which was undoubtedly pure analysis; it would certainly have been something very great. On the other hand, he popularised the Maxwellian theory of electricity, and ultimately mastered it, as well as more recent developments, so that he was able to make contributions to the theory of electrons and that of diffraction. And even in a bare outline, such as this, of his best work, we ought not to pass over his masterly papers on potential and similar subjects, which form the bridge, so to speak, between Neumann and Fredholm.

Poincaré did not disdain to write for a popular audience. "La Science et l'Hypothèse" has deservedly had a wide circulation, and affords a good view of the author's personality. With all his genius, Poincaré was an orthodox thinker by nature; in the case of non-Euclidean geometry, which he fully appreciated, his criticisms are acute and valuable; his sceptical attitude towards Cantor's theory of transfinite numbers is amusing, but not altogether surprising, and is perhaps the only instance of his shutting his eyes to a great mathematical discovery. Kelvin's long opposition to the electromagnetic theory of light is another illustration of the same sort of thing.

To give a just estimate of the value of the researches of Henri Poincaré is not possible at the present time, nor is it necessary. The almost immediate recognition they obtained, the increasing impression of their fundamental importance, and the numbers of students who have followed and expanded the ideas which he laid down with so sure a hand are the best testimony of their worth. We do not know what further contributions he would have made to mathematical science, had he lived, but we do know that what he achieved gives him a permanent place in the history of the subject.

THE PHYSICS OF THE UNIVERSE.

Lehrbuch der kosmischen Physik. By Prof. W. Trabert. Pp. x+662. (Leipzig and Berlin: B. G. Teubner, 1911.)

THE primary justification of a treatise on cosmical physics is to be sought in the principle that economy of communication is of the very essence of science. The author of such a book cannot hope to deal so competently with the individual subjects as the experts to whose writings he must have recourse for his own knowledge, but his work will be a real contribution to the progress of science if he succeeds in imparting unity to his treatment of subjects which have been developed by different workers, each more or less superficial in his knowledge and appreciation of the work of those outside his own branch. Judged from this point of view Prof. Trabert's book is successful. It has been developed according to a definite and well-ordered scheme.

A natural impulse is to compare the book with the masterly treatise with the same title which Arrhenius published ten years ago. The principal difference between the two works is in size and order. The older book covers 1000 pages, of which about 400 are devoted to meteorology; the new one contains 650 pages, of which only about 100 can be spared for meteorology. Arrhenius starts with the "Physik des Himmels," the stars, the sun, the planets, and proceeds from that to the "Physik der Erde," the form and constitution of the earth and the sea, the tides and the ocean currents. He deals finally with the "Physik der Atmosphäre," meteorology, atmospheric electricity, and terrestrial magnetism. Trabert begins with an introductory chapter on the fundamental ideas of the physical concept of the universe. He then deals in order with the form of the earth and its place in the universe, the phenomena of motion—the motion of the sun, the stars and the earth, and tidal and earthquake phenomena, the processes of radiation, with especial reference to the earth's atmosphere, the exchange and transformation of energy, and finally with the development of the universe. Position, motion, energy, result, may be taken to represent briefly the order adopted.

A feature of the book is the care with which the historical development of the principal methods and ideas has been treated, and the retrospective chapters at the end of each section are especially interesting. Thus in the first section the determination of the distances of the sun and moon is traced from its earliest beginnings with Aristarchus and Hipparchus, down to the first exact measurements by Lacaille and Lalande, and the results of Newcomb and Gill. In the second section the different arguments for the rotation of the earth are set forth, including the observed deflection of the wind towards the right; we may commend to those who are sceptical of the effect of the earth's rotation upon motion along the surface the account, on p. 129, of the effect produced on the Hamburg-Harburg railway prior to 1877. In the account of seiches which is given in this section, no mention is made of the work of Chrystal and Wedderburn, and in dealing with star-streams no reference is made to Schwarzschild's hypothesis and the later developments. Such omissions, if they stood alone, might be regarded as incidental to the character of the book, but they indicate a lack of appreciation of recent developments which becomes astonishing when one finds no direct reference to the most important development of Prof. Trabert's own subject in recent years, *i.e.*, the discovery of the stratosphere and its explanation, with the concurrent development of our knowledge of atmospheric radiation and dynamical meteorology.

Apart from this blemish the book appears to be excellent. The use of mathematical formulæ has been avoided as much as possible, but wherever a mathematical demonstration affords the simplest and readiest proof of a result or is necessary for the strict development of the subject, the author has not hesitated to use it; frequently, however, he has given the general outlines of the reasoning in the text, and added the formal proof as a footnote.

The chief characteristic of the book is the broad view of the subject which the author has taken, and it is no doubt due to his desire to give an unbiassed treatment that he has dealt so sparingly with meteorology. That appears to have been an error of judgment, but the result is preferable to a book overloaded with unnecessary details.

E. Gold.

FOODSTUFFS.

(1) *The Chemistry of Breadmaking.* By James Grant. Pp. viii+224. (London: Edward Arnold, 1912.) Price 5*s*. net.

(2) *Cocoa and Chocolate: Their Chemistry and Manufacture.* By R. Whymper. Pp. xi+327. (London: J. and A. Churchill, 1912.) Price 15*s*. net.

(3) *Cocoa: Its Cultivation and Preparation.* By W. H. Johnson. Pp. ix+186. (Imperial Institute Handbooks.) (London: John Murray, 1912.) Price 5*s*. net.

(4) *Foods: Their Origin, Composition and Manufacture.* By Dr. William Tibbles. Pp. viii+950. (London: Baillière, Tindall and Cox, 1912.) Price 18*s*. net.

(1) MR. GRANT'S preface implies that he set out to write a book suitable for the use of persons actually engaged in breadmaking, who have not had a scientific education and yet are desirous of knowing something about chemistry, physics and mycology in their relation to this industry. The book therefore covers a good deal more ground than is indicated by its title. Mr. Grant, in fact, attempts too much in the space at his disposal. As a result his descriptions are often so condensed and so full of unexplained scientific and technical terms as to be difficult reading to the special class of students indicated in his preface, even if they take his advice and study it "in conjunction with some simple text-books on chemistry, physics, mechanics, and the elements of biology and botany."

To students who have had some training in science or are studying breadmaking under a competent teacher at a trade school, the book will be quite useful, giving, as it does, a concise and trustworthy account of the whole subject. It is to be hoped that students using the book will not acquire Mr. Grant's habit of assigning unusual meanings to well-known words. Such a direction as "dry, desiccate and weigh" is a little puzzling when the word "desiccate" is taken in its ordinary sense.

(2) Mr. Whymper is a cocoa enthusiast, and the introduction to his book has about it faint suggestions of the mural literature so copiously devoted to this "grateful and refreshing beverage." He divides his subject-matter into three parts, dealing first with the botany and cultivation of the plant and the preparation of the beans, then with the manufacture of cocoa preparations, including chocolate, and lastly with the chemistry of cocoa. Though nearly everything that Mr. Whymper says in the first of these three parts is sound, this portion of the book, merely on account of its brevity, is scarcely up to the standard of the other parts. Thus, under preparation there is no reference to the fact that much of the Gold Coast cocoa is marketed in an unfermented condition, nor is it stated that some manufacturers in the United Kingdom prefer "unwashed" cocoa, alleging that it is of better flavour than the washed article. The statement that "claying" cocoa provides an additional protection against mould and fungoid growths may be true, but, in view of the fact that this practice easily degenerates into mere "weighting" of cocoa, it should have been mentioned that many manufacturers prefer cocoa that has not been "clayed."

Mr. Whymper's main object, however, is to discuss the manufacture and the chemistry of cocoa, and these sections of the book are very well done. The manufacturing processes are described clearly and concisely, and the changes in composition occurring at each stage of manufacture are carefully and thoroughly discussed. Analysts who have to deal with cocoa and its products will be grateful for the comprehensive and critical survey of the chemistry of cocoa provided in the third section. The book is well produced and the illustrations of plantation scenes and of machinery are very good.

(3) Most of the books on the cultivation of cocoa that have appeared so far have been written with a bias in favour of the practice of some particular area. Mr. Johnson escapes the temptation to err in this direction for the reason that, although his experience has been acquired chiefly in the Gold Coast, he has also had the opportunity of investigating cocoa cultivation in San Thomé, Ceylon, and the British West Indies, and has thus seen the industry carried on under widely different conditions. In discussing such important matters as the selection of a site and the formation of a plantation, he first states the climatic and soil requirements of the plant. The planter, using these data as a guide, is thus placed in the position of being able to select or modify methods to suit his local conditions, instead of being asked to follow blindly some particular practice, which gives good results elsewhere. The preparation of cocoa for the market, and especially such fundamental matters as fermentation, washing, and "claying," are very well discussed, not only from the planters'

point of view, but also from the more important one of the requirements of different markets. Two chapters are devoted to diseases and pests affecting the plant, and the appropriate preventive or remedial treatment for each is indicated. The volume is the second in the series of "Imperial Institute Handbooks," prepared with special reference to the requirements of British West Africa. It should prove especially useful in the Gold Coast, where cocoa is now the principal article of export.

(4) Dr. Tibbles's book is divided into five sections. The first deals with the nature, characters, and classification of the constituents of foods, and, though much condensed, serves to give a clear idea of the remarkable complexity of food, when considered in terms of the chemical compounds forming it. The second section covers foodstuffs of animal origin, meat and meat preparations, game, fish, cheese, butter, and other materials of this class being considered in turn. The commercial sources of each product, its manufacture and composition, and the characters which distinguish sound from unsound material are discussed, and notes are added regarding the advantages or disadvantages of each product as a food. The third section deals in like manner with foods obtained from plants. In the last two sections spices and condiments and beverages are discussed, the latter including tea, coffee and cocoa, as well as malt liquors and spirits.

The chemist who uses this book will find some of the data which especially concern him rather antiquated, and some of the statements so condensed as to be not strictly accurate. These and other defects of the same kind are, however, relatively unimportant in a book like this, which brings together for the first time a mass of carefully selected and classified information concerning foodstuffs. Dr. Tibbles is to be congratulated both on the courage which led him to undertake this task and the success with which he has achieved it.

TECHNICAL, POPULAR AND ECONOMIC ZOOLOGY.

(1) *Le Zebre.* Studio Zoologico Popolare. By Dr. Achille Griffini. Pp. xxviii+298; illustrated. (Milano: Ulrico Hoepli, 1913.) Price 4 lire.

(2) *La Pêche au Bord de la Mer.* By Lucien Jouenne et J.-H. Perreau. Pp. 311. (Paris: J.-B. Baillière et Fils, 1912.) Price 4 francs.

(3) *Bees shown to the Children.* By Ellison Hawks. Pp. xii+120; illustrated. (London and Edinburgh: T. C. and E. C. Jack.) Price 2*s.* 6*d.* net. (The "Shown to the Children" Series.)

(4) *A Hand-list of British Birds.* With an account of the distribution of each species in the British Isles and abroad. By Ernst Hartert, F. C. R. Jourdain, N. F. Ticehurst and H. F. Witherby. Pp. xii+237. (London: Witherby and Co., 1912.) Price 7*s.* 6*d.* net.

(5) *Liverpool Marine Biology Committee: L.M.B.C. Memoirs on Typical British Marine Plants and Animals.* Edited by Dr. W. A. Herdman, F.R.S. XX. Buccinum (the Whelk.) By Dr. Wm. J. Dakin. Pp. viii+115+8 plates. (London: Williams and Norgate, 1912.) Price 4*s.* 6*d.*

(6) *Das Tierreich.* 31 Lieferung: Ostracoda. By G. W. Müller. Pp. xxxiii+434. (Berlin: R. Friedländer und Sohn, 1912.) Price 32 marks.

THOSE interested in zebras and quaggas will find an excellent account of these animals in Dr. Griffini's little book (1), which is one of the series of useful manuals edited and issued by Ulrico Hoepli, of Milan. That he has thoroughly grasped the conclusions of the most trustworthy recent authorities is shown by his discussion and rejection of the claim that the existing striped Equidæ can be logically entitled Hippotigris, by his adoption of the view that four, and only four, species, namely, *Equus grevyi, E. zebra, E. foai* and *E. quagga*, the latter including as subspecies all the so-called *burchelli* forms, can be admitted, by his summary of the evidence supporting the celative significance of the coloration, and of the evidence favouring the view that the pale, and not the dark, bands are in reality the "stripes." Writing as an expounder rather than as an original researcher, Dr. Griffini is, of course, aware that his classification and synonymy of the local races of *E. quagga* must be regarded as tentative instead of final; but, considering the difficulties of the question, his attempts at its settlement, although not above criticism, do credit to his perspicacity. We have only one serious fault to find with the book. It has no index. In the place where the index should be is a complete list of the author's contributions to zoology, which show that his time has been mainly devoted to the study of systematic entomology. Perhaps it is to the training thus acquired that is to be attributed his masterly handling of the subject-matter of this volume.

Shore-fishing in all its branches, from the finding of cockles in the mud, the extraction of congers and crabs from rock-clefts, and the capture of mackerel with spinner or net, to the more refined art of fly-fishing, is fully dealt with in "La Pêche au Bord de la Mer" (2), one of the volumes constituting the "Bibliothèque des connaissances utiles." If translated into English, the book ought to have a ready sale on this side of the Channel, because the marine and estuarine animals it describes and illustrates are those with which all shore collectors and amateur fishermen are familiar. To these the book may be recommended without reserve.

(3) The gift of writing science for children is much rarer than is usually supposed. If it can be acquired, Mr. Ellison Hawks has much to learn in the use and disuse of words and in the handling of subject matter before he can hope to qualify for a place in the small band of authors endowed with the gift. Apart from this defect and a few of less moment, his book on bees is quite good in its way, and holds all about the structure, habits, and practical keeping of honey-bees that the ordinary layman is likely to want.

Not without misgivings on the score of the probable suppression or transference of long-cherished and familiar names did we look through the new "Hand-list of British Birds," by Messrs. Hartert, Jourdain, Ticehurst and Witherby (4). That our fears were justified in a measure is shown by the appearance of some strange, often uncouth, terms, like *borin* for *hortensis* for the garden warbler, by the transference of *musicus* from the song thrush to the redwing, and by a most disconcerting shuffling of the names of our owls. The barn owl, for example, so familiar as *Strix flammea,* is now *Tyto alba,* its generic name *Strix* going to the tawny owl and its specific name *flammea* to the short-eared owl! We are forced to admit, however, that until systematic zoologists agree on the question of exempting certain names from the law of priority, conscientious compilers of catalogues are compelled to put it in force. On the other hand, we welcome the suppression of many generic names, and rejoice that the blackbird is still a Turdus, that the rook finds a place in Corvus, and that the kestrel, gyrfalcon and merlin are associated with the peregrine under Falco. The volume, which deals with distribution and migration as well as with names, is useful and carefully compiled, and will have to be seriously reckoned with by all writers on British birds, despite the protests to which its nomenclature is sure to give rise.

(5) In Mr. Dakin's memoir on the whelk (Buccinum) zoological students will find an admirable and well-illustrated treatise on the anatomy of this common gastropod, supplemented by brief accounts of its embryology, distribution and economics.

(6) Like all the volumes of "Das Tierreich" which deal with obscure groups, Dr. Müller's monograph of the Ostracoda is a colossal piece of work. More than nine hundred species of these minute Entomostraca are tabulated and classified. It will give a fresh impulse to the study of the group, but cannot be regarded as final, since something like six hundred named species have to be set aside, through no fault of the author, as *dubiae.* What a benefit it would be to the study of such orders as this if specialists would abandon for a time the description of new species and seriously address themselves to the task of classifying properly those that have already been described!

R. I. P.

OUR BOOKSHELF.

Biologische und morphologische Untersuchungen über Wasser- und Sumpfgewächse. By Prof. H. Glück. Dritter Teil:—Die Uferflora. Pp. xxxiv + 644 + viii plates. (Jena: Gustav Fischer, 1911.) Price 33 marks.

PROF. GLÜCK has produced a portentous volume on the riparian flora, forming the third instalment of his work on water and swamp plants. Frankly, we do not find justification for the 600 or more pages of his book, and we fancy most readers who have been in the habit of using their eyes when observing or collecting plants will find but little to reward them for the trouble of its perusal.

There are many examples, often of very moderate interest, adduced to illustrate the fact that submerged forms are apt to differ from the terrestrial representatives of a given species. Here and there, however, interesting observations are recorded, *e.g.*, the very different water and land forms of *Veronica Beccabunga.*

The author claims many new "forms," *e.g.*, *Veronica Beccabunga forma submersa,* Glück. Many of these are already known, though possibly not recorded, nor even dignified with a Latin name.

Species undergo fission, as they are apt to do in the hands of those who concentrate attention on variable forms. It is, however, fair to say that many of these rest on the authority of other writers before Glück, but it would have been of more general interest had the claims to specific or even mutational rank been experimentally settled.

No doubt a work of this kind possesses some value, but, as it appears to us, it excellently illustrates the truth of the saying that the secret of dullness lies in the attempt to write all one knows. Prof. Glück gives the impression (perhaps unjustly) that he has written all he knows about his subject, and certainly he has jotted down a good deal that is already very familiar to others.

The Teratology of Fishes. By Dr. James F. Gemmill. Pp. xvii + 73 + xxvi plates. (Glasgow: James MacLehose and Sons, 1912.) Price 15*s.* net.

DR. GEMMILL's memoir is mainly a very complete and well-illustrated account of the structure of the major abnormalities, or double, triple, and cyclopean monstrosities, in salmon and trout. The author tells us that the bony fishes are specially important for the study of teratological variation; oviparity and the abundance of eggs ensure plentiful material at all stages for observation and experiment, and although the major types rarely live after the yolk has been absorbed, at this time nearly all the organs, except the bony skeleton, have attained their adult form and relations.

Double monsters, and especially those that are double at the anterior end, are so numerous and variable that they require detailed classification, and in his arrangement Dr. Gemmill differs from his predecessors by taking into consideration the internal structure.

In addition to the chapters on the major abnormalities, which form a valuable original contribution to vertebrate teratology, there is one on minor abnormalities, which aims at facilitating the task of the future worker by introducing him to the literature of the subject, and should be very useful for this purpose. C. T. R.

Über die krankhaften Erbanlagen des Mannes. By F. Lenz. Pp. iv + 170. (Jena: G. Fischer, 1912.) Price 4.50 marks.

THIS is an interesting discussion of the inheritance of hæmophilia and other sex-limited conditions in man and animals, and their bearing on the determination of sex. In the case of hæmophilia the author believes that an affected man never transmits the disease, even through his daughters to his grandsons, and supposes that this is due to non-viability of spermatozoa bearing the factor for the affection. This conclusion is difficult to accept when hæmophilia pedigrees are compared with those of other sex-limited affections. He also concludes that the apparent abnormalities of the sex-ratio in affected families, and the excess of affected members over unaffected, are likewise due to incompleteness in the records. In his examination of sex-limited inheritance in general the author has read widely, but sometimes misunderstands those whose writings he discusses. His hypothesis of the mode of inheritance and of sex-determination seems to differ more in form than in substance from previously suggested factorial schemes. The work as a whole is one more illustration of the fact that for the solution of the problem further investigation is needed rather than discussion of what is already known.

New "Contour" Wall Map of the Mediterranean Lands. 40 × 76 inches. Scale 1 : 4,067,712, or 64·2 miles to one inch. (London: G. W. Bacon and Co., Ltd.) Price 16*s*.

THIS is an effective wall map which will be useful for class purposes. Two editions—with and without land names—are available. The map includes all the countries which at any time formed part of the Roman Empire, and both ancient and modern names are given, when these are shown. It is somewhat a disadvantage that the scheme of colouring to show land relief is not that usually adopted, and the blue stippling used to indicate areas with less than ten inches of rainfall can be seen only by a person standing near the map.

The map is constructed on a secant conical projection, and it may be obtained on cloth, with rollers, and varnished; or on cloth cut to fold.

Leather Chemists' Pocket-Book. A Short Compendium of Analytical Methods. Edited by Prof H. R. Procter, assisted by Edmund Stiasny and Harold Brumwell. Pp. xiv + 223. (London: E. and F. N. Spon, Ltd., 1912.) Price 5*s*. net.

THIS handy little volume is intended as an adjunct to the "Leather Industries Laboratory Book," by Prof. Procter, which was published in 1908. The pocket-book is based upon the manuscript laboratory sheets, giving the course of analysis essential to the practical student, in use in the authors' laboratory in the University of Leeds. The book should be particularly useful to students in evening classes studying the science and technology of the leather trades.

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.]*

X-rays and Crystals.

IN his discussion of Dr. Laue's diagrams Dr. Tutton (NATURE, November 14, p. 309) invites me to consider their physical aspects in the light of the crystallographical details which he supplies.

The rule which I gave in a previous letter to NATURE (October 24, p. 219), and which Dr. Tutton has in mind, is independent of all but the simplest facts of crystallography. It gives a numerical method of finding the positions of the spots on the diagrams, and its effect is merely to show that the positions of the spots give no information concerning the wave-length of the incident radiation.

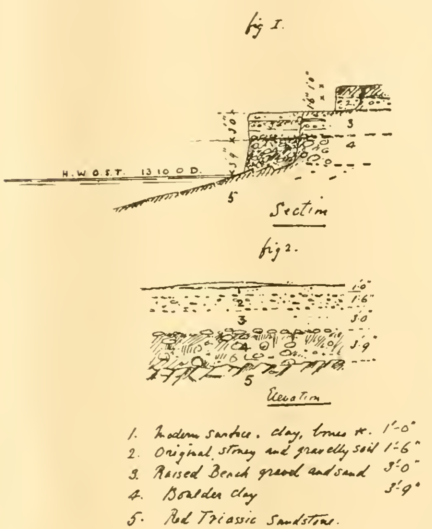
In a paper read recently before the Cambridge Philosophical Society my son has given a theory which makes it possible to calculate the positions of the spots for all dispositions of crystal and photographic plate. It accounts also for the form of the spots and other details, and amongst other things it explains my numerical rule. It is based on the idea that any plane within the crystal which is "rich" in atoms can be looked on as a reflecting plane; the positions of the spots can then be calculated by the reflection laws in the ordinary way. In this extended treatment the facts of crystallography are of importance, but it would take too long to discuss the matter in a letter.

I should like to refer to one other point. Dr. Tutton suggests that the new experiment may possibly distinguish between the wave and the corpuscular theories of the X-rays. This is no doubt true in one sense. If the experiment helps to prove X-rays and light to be of the same nature, then such a theory as that of the "neutral pair" is quite inadequate to bear the burden of explaining the facts of all radiation. On the other hand, the properties of X-rays point clearly to a quasi-corpuscular theory, and certain properties of light can be similarly interpreted. The problem then becomes, it seems to me, not to decide between two theories of X-rays, but to find, as I have said elsewhere, one theory which possesses the capacities of both.

W. H. Bragg.

Worked Flints obtained from "the 25-foot Raised Beach" near Holywood, co. Down.

The 25-foot raised beach is well marked all round the northern and eastern coast of Ireland, and is also recognisable on the opposite coast of England and in the Isle of Man. This post-Tertiary beach is contemporaneous with the Upper Estuarine Clays of the Belfast sections,[1] and is certainly not later than early Neolithic. At different times worked flints have been obtained from this beach, notably from Larne, co. Antrim, and have been discussed, but no clue to their date or dates has been found. I have lately had the opportunity of carefully examining the section



(Fig. 1 and 2) near Holywood, co. Down. From a 350-ft. exposure 683 worked flints were obtained.

Description.		Per cent.	Notes.
Scrapers	Concave 70, Convex 17, Straight 76	29·6	Chipped on non-bulbous face only. 4 Le Moustier type.
Knives	"Parrot-beaked" 39, Straight 80	21·6	All with tang. Worked on non-bulbous face only. 20 per cent. with shoulder (Les Eyzies).
Simple flakes	110	20·0	85 per cent. showing central ridge.

Punches, adzes, chisels, celts, cores, borers, microliths, about 4 per cent. each class.

No polished specimen was obtained, and all were of Palæolithic form, generally chipped on one face only. From the surface of the Boulder Clay specimens were obtained which had been subject to rolling before settlement of the land took place. Eight specimens showed re-chipping. Three prickers made from the ulna of deer were found. I submit that, considering the evidence of late Palæolithic work in Scotland in a similar horizon, the geological evidence, and the form and working of the flints found in this beach, they should be described as Mesolithic.

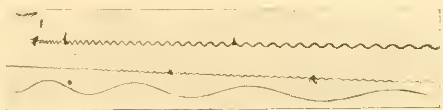
Henry Home.

Bellevue, Holywood, co. Down.

[1] Praeger, Proc. Roy. Irish Acad., vol. iv., 1897.

Note on the Upper Partials of a Tuning-fork.

It is well known that a smoked dropping plate can be used to find the pitch of a fork if the value of g is known, and the method is described in most of the text-books on sound. But so far as the writer is aware no attention has been directed to the fact that the existence of some of the upper partials can also be demonstrated with it and their frequency obtained. The method is simpler and more convincing to a student than the method of using resonators.



As an example the traces of the fundamental and the first two upper partials are shown in the diagram, which is a copy of the photograph of the traces on the dropping plate. The fundamental frequency of the fork used was 29·5, and the frequency of the first two upper partials should be (see Barton, "Text-book of Sound," §211) 185 and 518, while the numbers obtained from a single observation were 184 and 512 respectively. No attempt was made to obtain other partials, but doubtless the next two could have been obtained.

F. H. Parker.

Woolwich Polytechnic, November 9.

The March of Science.

In a school text-book, published in 1846 at Philadelphia, from which I was instructed in 1848—it was a geography, but contained five lessons in astronomy—is the following information about the sun:—

"In former times, it was supposed that the sun was a great ball of fire. Many learned men, however, are of opinion that it is a world like our own, containing continents, oceans, mountains, and plains.

"It is supposed that the rays of light which illu mine the Solar System, proceed from an atmosphere, or air, of a peculiar nature, that surrounds the sun. The rays of the sun are called solar rays.

"When mingled with the atmosphere on the surface of the globe, it is thought that these rays produce the warmth and animation which render the earth habitable.

"This appears probable, from the fact that the summits of high mountains are always covered with ice and snow, while at their base, and in the valleys, the heat is oppressive. If heat proceeded from the sun, as from a body of fire, the higher we ascend from the surface of the earth, the greater the heat would become."

As I was only seven years old at the time I studied the book, the information did me no harm.

E. S.

Brookline, Mass., U.S., November 9.

FOREST CULTIVATION IN TROPICAL REGIONS.[1]

THE author of this book has done well to restrict it to the sylviculture of tropical forests instead of attempting the wide subject of forestry, of which, however, sylviculture is the most important branch. His definition of sylviculture is "the art of applying the knowledge of the requirements of different trees, in tending and regenerating existing woods, or in rearing fresh woodland crops and in working them to the best advantage of the forest owner," so that it is the cultivation of forest crops in distinction to arboriculture, which is the cultivation of individual trees.

FIG. 1.—Arid zone deciduous forest in the Sudan; *Acacia Verek* trees. From "Sylviculture in the Tropics."

The personal experience which has fitted Mr. Broun to write about tropical sylviculture has been gained only in India, Ceylon and the Sudan, the countries in which he has served as a Government forest officer, and this has to be remembered, because the kinds of forest of which he treats are only to be found in those countries. In his preface, however, he expresses the hope that what he has written may not be found to disagree with the experience in other tropical regions. It might perhaps have been better to have called his book "Tropical Sylviculture in India, Ceylon and the Sudan," and so to have avoided the more general but somewhat misleading name actually adopted.

The chapter on soil is a general one, but that on climate applies strictly to the belt of the earth's surface contained between the two tropics. In this belt the zones of forest vegetation naturally differ according to the greater or less dampness, so that the five of which he treats vary from the "desert zone," where the average annual rainfall is under 4 in., to the "wet zone," where it is above 75 inches. The Sudan forests, a good idea of some of which is given by the picture here reproduced, come chiefly into the arid zone (rainfall 4–16 in.), while those of India and Ceylon are distributed in all the zones, the most important one for valuable forests being the "moist zone" (40–75 in.), illustrated at p. 23 by a picture of a Ceylon Mimusops forest. It is a pity that there is no picture of a forest of the Indian teak.

Perhaps the most interesting chapter in the book, at any rate for the forester, is chapter viii, which treats of natural regeneration, and describes the reproduction of forest by natural means as distinct from artificial. Works of planting and sowing are, it is true, very fully described, but in the vast areas which have to be treated in most tropical regions it must be on natural reproduction chiefly that a forester has to depend to ensure continuance of forest growth and continued improvement instead of deterioration. Mr. Broun describes how most tropical forests which have been taken under scientific management have previously suffered during centuries of ill-usage, so that every effort has to be made to restore them to what is called a "normal" condition, fit for regular systematic working tending to the production of a permanent and regular annual yield.

FIG. 2.—Moist zone evergreen forest in Ceylon; *Mimusops hexandra* in foreground. From "Sylviculture in the Tropics."

[1] "Sylviculture in the Tropics. By A. F. Broun. Pp. xviii+309. London: Macmillan and Co., Ltd., 1912.) Price 8s. 6*d*. net.

The question of works for the protection of forest from fire naturally has to be carefully gone into, and Mr. Broun's chapter on this subject is interesting and instructive, as also is the last chapter, in which the measures necessary for the fixation of unstable soils, whether of blown sand or of precipitous slopes, are described.

The book is illustrated by excellent wood-cuts, as well as by photographic reproductions of forest scenes, and these have chiefly come from Ceylon, representing a more or less wet country, or the Sudan, representing a dry one. We should have liked to see more reference to Indian experience and practice, for although no doubt the efforts of experienced foresters like Mr. Broun have done a great deal for Ceylon and the Sudan, the far greater and longer-continued work in India must now be certainly placed in the forefront of tropical forest experience.

The book is very well printed, illustrated and bound, though rather too heavy for a forester's wallet; and it contains a large amount of valuable and most interesting information which should make it a useful guide to foresters, especially in those countries which are chiefly referred to.

DR. RAMSAY H. TRAQUAIR, F.R.S.

WE regret to record the death of Dr. R. H. Traquair, F.R.S., of Edinburgh, which occurred early in the morning of November 22 after a long period of failing health. Born at Rhynd, Perthshire, on July 30, 1840, Dr. Traquair received his early education in Edinburgh, and at the age of seventeen became a student of medicine in the University of that city. In 1862 he graduated as M.D., and was awarded a gold medal for his thesis on the asymmetry of the flat-fishes, which was published four years later in the Transactions of the Linnean Society. He had studied medicine, not with a view to medical practice, but merely because this course seemed most likely to afford him an opportunity of gratifying an early ambition to devote his life to biological science, which had attracted him since childhood.

After obtaining his degree, Dr. Traquair accordingly remained at the University as prosector to Prof. Goodsir, and from 1863 to 1866 he was demonstrator of anatomy. After serving for a few months as professor of natural history in the Royal Agricultural College, Cirencester, he removed to Dublin in 1867 as professor of zoology in the newly founded Royal College of Science. Finally, in 1873, he was appointed keeper of the natural history collections in the Museum of Science and Art (now the Royal Scottish Museum) in Edinburgh, where he remained until his retirement in 1906.

Though interested from the first in all branches of natural history, Dr. Traquair soon began to devote most of his energy to the study of fossil fishes, which became the absorbing pursuit of his long and active life. While still a boy he had found part of a Palæoniscid fish in an ironstone nodule on the beach at Wardie, near Edinburgh, and the impossibility of interpreting what he saw, even with the aid of the standard works of the time, led him to begin the long series of researches which have revolutionised our knowledge of Palæozoic fishes and thrown light on some of the most fundamental problems of ichthyology.

Beginning in this manner with material which he had himself collected, Dr. Traquair worked out in detail the osteology of several Carboniferous fishes, and with these he compared the imperfectly known fishes from the Scottish Old Red Sandstone. The first important result of these researches was reached in 1877, when he published the preliminary part of his "Monograph on the Ganoid Fishes of the British Carboniferous Formations" in the Palæontographical Society's volume for that year. He showed that the Palæoniscidæ and Platysomidæ, which had until then been compared with the existing Lepidosteus, were really primitive Chondrostean fishes closely related to the modern sturgeons. He thus proved that the nature of the scaly covering of fishes was of little importance in classification compared with that assigned to it by Agassiz; and he was the first to point out the more fundamental characters of the internal skeleton which have subsequently been recognised as unfailing guides to a natural classification. In short, he made it possible to distinguish between the phenomena of parallelism or convergence, and the marks of natural affinity in the early fishes.

While studying the Palæoniscidæ, Dr. Traquair also devoted much attention to the Crossopterygian and Dipnoan fishes, and published many exact descriptions of their osteology. He showed that the Devonian Dipterus and Phaneropleuron were closely related to the existing Ceratodus, while his interpretations of Crossopterygian skulls now prove increasingly important for comparison with the newly discovered skulls of the early Labyrinthodonts.

In his later years, Dr. Traquair made another important contribution to our knowledge of fishes by his numerous descriptions of the Upper Silurian Ostracodermi discovered by the Geological Survey in southern Scotland. He demonstrated that the armour-plates of such genera as Pteraspis and Cephalaspis are formed by the fusion of simple granules of shagreen with each other and with hard tissue developed in a deeper layer of the skin. He thus proved the truth of the theory of the origin of the vertebrate exoskeleton, which had already been formulated from the study of comparative morphology.

Apart from the successive instalments of his palæontographical monograph, Dr. Traquair's last work was his memoir on the Wealden fishes of Bernissart, Belgium, published in 1911 by the Royal Museum of Natural History, Brussels. This was to him a new subject, and involved much labour for several years, but it was eventually produced with his usual thoroughness, and will long remain a standard work of reference.

Dr. Traquair was an artist as well as a naturalist, and he made a large proportion of the beautiful drawings which illustrate his published works.

His numerous restored figures of the fishes he described are especially important, combining artistic style with the most minute accuracy, and left incomplete wherever there is the least doubt as to structure. Both in writing and in drawing, indeed, he always aimed at such precision that his publications were often delayed for a long period by hesitation, and his correspondents were accustomed to regard his dilatory methods with impatience. Even so unique a fossil as the Lower Devonian Palæospondylus was in his possession upwards of ten years before he ventured upon its description, and he only published an account of it when specimens seemed likely to fall into less competent hands. Dr. Traquair was, in fact, a genuine student, anxious only to make sure of the truth, and a large circle of friends will mourn the loss of one whose kindly spirit endeared him to all who came in close contact with him.

Dr. Traquair was elected a fellow of the Royal Society in 1881, and received the honorary degree of LL.D. from the University of Edinburgh in 1893. He was awarded the MacDougall-Brisbane medal of the Royal Society of Edinburgh, and also the Lyell medal of the Geological Society of London, in 1901, and a Royal medal of the Royal Society of London in 1907. A list of his writings and an excellent portrait of him accompany a biographical notice published in *The Geological Magazine* for June, 1909. A. S. W.

W. F. KIRBY.

WILLAM FORSELL KIRBY, whose death on November 20 we regret to announce, was the eldest of the five sons of Samuel Kirby, banker, of High Street, Leicester. He was born at Leicester, January 14, 1844. When a boy of seven Kirby was taken to London, and saw the British Museum and Gould's collection of humming birds, and, while still very young, when the family moved to a house two or three miles from Leicester, his mother suggested that he should collect butterflies, and thus aroused his first interest in entomology.

Kirby was privately educated by tutors. He always believed that exclusion from the life and experiences of a public school was a permanent disadvantage to him.

Samuel Kirby died in 1854, and the family moved to Burgess Hill and to Brighton (1857–60). Kirby, although still quite a boy, joined the Brighton and Sussex Natural History Society, and began to publish notes in *The Entomologist's Weekly Intelligencer*. He went to London in 1860, joined the Entomological Society in 1861, and soon became acquainted with all its leading members with Westwood, Hewitson, Stainton, Knaggs, and Perceval Wright. In 1866 he married Johanna Maria Kappel, daughter of J. W. Kappel, of Hilden, near Düsseldorf. Their only child, now W. Egmont Kirby, M.D., was born in 1867. Mrs. Kirby interested herself in all her husband's work, helping him in every possible way, and her death in 1903 darkened the last years of his life.

From 1867 to 1879 Kirby was an assistant in the museum of the Royal Dublin Society, afterwards the National Museum of Science and Art. On the death of Frederick Smith, in 1879, he moved to London, and entered the zoological department of the British Museum.

It is impossible on the present occasion to do more than allude to the series of volumes by which W. F. Kirby helped to stimulate and spread an interest in natural history. Among the numerous works which he wrote for the student of insect systematics special mention must be made of the "Synonymic Catalogue of Diurnal Lepidoptera" (1871). Few books have done more for their subject than this careful and accurate work, which was suggested to the author by the sight of H. W. Bates's MS. lists.

Between 1869 and 1884 Kirby wrote the reports on Lepidoptera, and later on the greater part of the insects for the "Zoological Record"—a work for which he was specially qualified by his wide knowledge of languages. Kirby's publications also deal with Scandinavian and Finnish folklore, a subject which deeply interested him. He was for a time one of the hon. secretaries of the Entomological Society, and was honoured by foreign scientific societies. He was ever ready to put his great knowledge at the disposal of other workers.

E. B. P.

NOTES.

THE anniversary meeting of the Royal Society for the election of council and officers will be held on Saturday next, November 30, at 4 o'clock p.m. There will be no meeting of the society to-day.

FULL particulars of the meeting, held at the Mansion House on October 23 last, to consider the whole question of the proposed memorial to Lord Lister were given in an article in the issue of NATURE for October 31 (vol. xc., p. 254). The meeting unanimously decided that the most suitable form of memorial would be:—(1) A tablet with medallion and inscription in Westminster Abbey; (2) the erection of a monument in a public place in London; (3) the establishment of an International Lister Memorial Fund for the advancement of surgery, from which either grants in aid of researches bearing on surgery, or awards in recognition of distinguished contributions to surgical science, should be made, irrespective of nationality. To carry out these proposals a large sum of money will be required, and the executive committee is appealing for donations to all persons who wish to pay a tribute to the memory of a great man of science and a great surgeon. Before the issue of this appeal subscriptions had been received amounting to something like 2700*l.*, and we notice that the first list of donations includes 500*l.* each from Lord Iveagh and Mr. W. F. D. Smith, 250*l.* from Mr. Otto Beit, 100 guineas each from Lord Northcliffe and Sir James Whitehead, Bart., and 100*l.* each from the Duke of Bedford, K.G., Sir Ernest Cassell, G.C.B., Sir W. Watson Cheyne, Bart., F.R.S., and Lord Rothschild, G.C.V.O. It is proposed to form committees in the provinces, in the dependencies of the Empire, and in foreign countries, to take such steps as are necessary in order to coordinate the collection of subscriptions. Donations may be sent to the "Treasurers of the Lister Memorial Fund, Royal Society, Burlington House, W." Cheques should be made payable to "The Lister Memorial Fund," and crossed "Bank of England, Western Branch."

REPORTS of an earth-shock at Sunninghill, Ascot, and other places at about 9 a.m. on November 19 were published in several London daily papers last week. In reply to an inquiry as to whether the alleged shock had been recorded at Kew, Dr. C. Chree, F.R.S., superintendent of the Kew Observatory, writes:—"The Kew seismic and magnetic records have been examined with the view of seeing whether there were any indications of seismic movements which could be associated with tremors and sounds recently reported from other parts of the London basin. There were, especially on November 19—though not at 9 a.m.—several tiny movements of the type which Prof. Milne now accepts as seismic provided they occur simultaneously at two or more stations. But the only movement that would naturally be accepted as seismic without such confirmation is one on the afternoon of November 19. Its beginning and end are open to considerable uncertainty owing to the presence of movements which may or may not be seismic. The movements shown extend from 1h. 57m. to 3h. 46m. p.m., with short interludes. The undoubtedly seismic movements extend from about 2h. 40m. to 3h. 0m. p.m. There are two maxima of movement, the larger 1·0 mm. (0·55″) about 2h. 44m., the smaller 0·- mm. about 2h. 56m. Owing to the long natural period of oscillation of the seismograph boom, the instrument is scarcely designed to show local short-period tremors of very small amplitude."

CABLEGRAMS received last week from Kingston, Jamaica, tell of a hurricane that had been experienced in that island which caused serious damage in the western part of it. The storm began on November 15 and continued with increasing fury for several days. The following telegram, received from the Governor of Jamaica, was read in the House of Commons on November 25: "Parishes of St. James's, Hanover, and Westmoreland suffered from two periods hurricane intensity Sunday, 17, and Monday, 18; all bananas in these parishes totally destroyed, bread-fruit, coconuts, and ground provisions seriously damaged, and native food supply crippled. Conditions of a similar kind to that of eastern parishes after 1903. Hurricane flooded gullies, destroyed houses recklessly placed in them; loss of life Montego Bay about 40; about 15 reported elsewhere; other casualties not extensive; canefields Westmoreland harried by wind, but will recover to a large extent for crop; some in St. James's damaged by flood débris; some sugar works destroyed, new factories stood well; as usual, destruction of flimsy and decayed tenements Savanna-la-Mar, Lucea, and country." The storm, doubless, was of the revolving type, and the centre probably passed considerably to the south and west of Jamaica. West India hurricanes are very rare in November, authentic records of such occurrences numbering fewer than a score in this month during the last 300 years. October and November storms keep, as a rule, well over to the western side of the ocean throughout their track, from their first appearance between the sixtieth and eightieth meridians of west longitude, until they disappear, while proceeding north-eastward between Newfoundland and the eightieth meridians.

IT is announced that Mr. Austen Chamberlain has received 48,000*l.* towards the 100,000*l.* which he is raising for the London School of Tropical Medicine.

THE RIGHT HON. EARL FORTESCUE has consented to accept the office of president of the twenty-eighth congress of the Royal Sanitary Institute, to be held at Exeter on July 7–12, 1913.

A LECTURE, entitled "Birdland through the Bioscope, in Colour," will be delivered by Mr. Oliver G. Pike in the new building of the Young Men's Christian Association, Tottenham Court Road, W.C., on Wednesday, December 4, at 8 p.m.

WE learn from *The Chemist and Druggist* that Prof. P. Sabatier, professor of chemistry at the Toulouse faculty of sciences, has decided to give his portion of the Nobel prize to the Toulouse Institute of Chemistry for the purpose of defraying the cost of new buildings for the institute.

WE are requested to state that a biography of the late Victoria Lady Welby is in course of preparation. It is hoped that her friends and correspondents may be willing to assist by placing such letters as they may possess at the disposal of her family The greatest care will be taken of the letters, and they will be returned to their respective owners intact at the earliest possible date. The letters should be sent to Sir Charles Welby, Bart., C.B., Denton Manor, Grantham.

THE death is announced by Reuter's Paris correspondent of M. Charles Bourseul, one of the earliest workers in telephony, at eighty-three years of age. M. Bourseul's suggestions for the electrical transmission of speech were acknowledged by Dr. Graham Bell and Mr. Edison more than thirty years ago, and the following extract from Prof. Cajori's "History of Physics" describes them:—"The earliest record of a theoretical telephone was contained in Du Moncel's 'Exposé des Applications,' Paris, 1854, when Charles Bourseul, a French telegraphist, conceived a plan of transmitting speech by electricity. The author says, 'Suppose a man speaks near a movable disc sufficiently flexible to lose none of the vibrations of the voice; that this disc alternately makes and breaks the current from a battery, you may have at a distance another disc which will simultaneously execute the same vibrations.' Bourseul did not work out his ideas to a practical end."

ACCORDING to an announcement in a recent number of the *Zeitschrift für Beleuchtungswesen*, an illuminating engineering society has now been formed in Germany. There are therefore now three such societies in existence, the society in the United States (formed in 1906), the society in London (formed in

1900), and the German society, formed this year, the constitution of which will doubtless be modelled on those of the other existing bodies. For some time there has been a need for a body capable of dealing authoritatively with illumination, photometry, standards of light, &c., in Germany, and the Reichsanstalt has been entrusted with the formation of the new society. A provisional committee has been formed, Prof. Warburg and Dr. E. Liebenthal being respectively chairman and secretary, and Herr Dettmar, representing the Verband deutscher Elektrotechniker, and Dr. Bunte, representing the Verein von Gas- und Wasserfachmänner, are also giving their assistance. The first ordinary meeting is to be held next February, when it is expected that Prof. Otto Lummer will deliver an address.

ENGLISH students of megalithic monuments in Cornwall will be interested in an article contributed to the *Bulletins et Mémoires de la Société d'Anthropologie de Paris* (vi. series, Nos. 1–2, 1912) by MM. Édouard and Paul Jeanselme under the title of "Inventaire descriptif et Mensurations des Principaux Monuments Mégalithiques de la Cornouailles," in which we have a series of careful measurements, descriptions, and drawings of rude stone monuments like the Logan Stone, the Cromlech of Zennor, the Lanyon and Mulfra Quoits, the Nine Maidens, and the Nineteen Merry Maidens, with other remains of the same kind in the Cornish peninsula. The writers remark that while these monuments are now carefully protected from destruction, atmospheric erosion is still carrying on the work of disintegration.

THE *Bulletins et Mémoires de la Société d'Anthropologie de Paris* (vi. series, Nos. 1–2) for 1912 are largely devoted to the question of steatopygy among the races of the Mediterranean area in ancient and modern times. As is well known, broad-hipped figures of this type have been discovered in France dating from the Magdalenian, Solutrian, and possibly from the Mousterian periods. A description of prehistoric images of the obese class is here given by Dr. Félix Regnault; and Dr. Atgier describes similar examples in modern times from south and south-east Africa and among existing Parisian women. Dr. Regnault discusses the differences between this type and the well-known Bushman or "Hottentot Venus." The question is of considerable importance to anthropologists, as it may imply a connection between the races of South Africa and those of the Ægean.

IN *The American Museum Journal* for October Mr. V. Stefánsson makes a powerful appeal for the protection of the new Eskimo tribes from pauperisation by a system of quarantine which will limit the entrance of conditions of civilisation into the territory occupied by them. He gives a melancholy account of the ravages of measles and other diseases introduced by sailors visiting their coast. The introduction of permanent houses in lieu of snow huts and tents has led to the growth of tuberculosis among them. Foreign dress has exercised a similar effect, and begging has increased under a system of ill-regulated doles. In the same issue of the journal Mr. Clark Wissler attempts to give a tentative summary of Mr. Stefánsson's recent discoveries, and of the possibilities of the introduction of European blood among the Eskimo.

THE sixth annual report, by Dr. Houston, on the results of the chemical and bacteriological examination of the London waters for the twelve months ended March 31, 1912, has recently been issued. It contains full details of the analyses made, and Dr. Houston expresses the reassuring opinion that seven years' work on the London water question has convinced him that to a progressively increasing extent the Water Board is securing the reasonable "safety" of the metropolitan water supply.

THE Education Committee of the Agricultural Department of the County Council for the County Palatine of Lancaster has issued a report on milk tests and records carried out during 1911 (Farmers' Bulletin No. 23). It strongly urges all owners of milking herds to weigh and test the milk and keep accurate records, so that unsatisfactory animals may be weeded out and the general standard of the herds raised. All that is necessary is a balance with bucket, which need not cost more than 30*s*., and the weighing need not be done more than one day per fortnight.

IN the twenty-first report of the Board of Health on leprosy in New South Wales for the year 1911, Dr. Ashburton Thompson summarises the cases of the year, and also gives a return of the number of persons who have been found suffering from the disease in this colony since 1883. Details of recent cases are given, and in emphasising the remarkable improvement which may take place in cases of leprosy without any special treatment whatever, he remarks: "I have so often seen similar improvement in similar circumstances that I am tempted to say that it is often enough to look steadily at a person who is suffering from leprosy to bring about some improvement, and often a marked improvement, in his general state, and even in some of the stigmata of his disease." A review of recent research into the causal organism of the disease is included in the report.

IN *The American Naturalist* for November Mr. A. L. Hagedoorn points out the essential difference in the nature of the colouring of tricoloured dogs and tricoloured guinea-pigs and cats. The former are never irregularly blotched with black and yellow after the fashion obtaining in the two latter, but are essentially either black and tan, or sable blotched with white. Some tricoloured dogs, such as fox-terriers, are black and tan blotched with white; others, like most hounds, sable; while yet others, such as collies, may be either black and tan or sable blotched with white. A dog with a yellow blotch on the back and a yellow foot appears unknown. It is not easy to understand in what sense the author employs the term "sable."

THE Seismological Society of America is doing useful work in encouraging the detailed study of the principal earthquake regions of the continent. The last number of the Bulletin (vol. ii., No. 3) contains the first of a series of papers on the earthquakes of Haiti. In this, Mr. J. Scherer examines the distribution of the great shocks which have occurred since the discovery of the island. He finds that their central areas oscillate along three great depressed zones, the more important being the northern depression from the Bay of Samana past Cap Haitien, and the southern depression passing in a parallel direction close to Port au Prince and connecting the deep ocean basin to the south of San Domingo with the well-known Bartlett Deep. Though these two zones are separated by not more than eighty miles, it is remarkable that an earthquake of the northern zone, which ruins towns so completely that they have to be rebuilt on other sites, may pass almost unfelt along the southern band.

The important problem of seasonal forecasts is being attacked from various points of view. Dr. Walker has applied the method of correlation in dealing with the Indian monsoon; Hildebrandsson has discussed the influence of the "centres of action"; Dr. Lockyer has considered the barometric see-saw in the southern hemisphere. In a paper published in 1909 Dr. Arctowski discussed the sequence of the variations of mean temperature and the changes from year to year in the positions of relatively warm and cold areas, and reached several interesting conclusions. He now discusses in the *Prac Matematyczno-Fizycznych*, tome xxi., the corresponding changes in atmospheric pressure in the United States. The results which he obtains do not appear to be definite enough to be suitable for practical application, although he states that the variations of pressure from the normal can be calculated several months in advance. The charts, on which his conclusions are based, are given for the years 1888, 1889, 1890, 1907, and 1908 only, and do not appear to furnish sufficient evidence either for or against his contention. He gives also a table showing that the departures from normal of pressure in North America are opposite to those in Iceland, but as the values are given for only thirteen selected years during the period 1876–1900, the table can scarcely be taken as proof of his statement that the see-saw is "incontestablement plus caractéristique" than that found by Lockyer for Cordoba and Bombay.

In order to determine the quantity of manganese, phosphorus, silicon, or sulphur in iron or steel, a certain precipitate is formed, and the weight of this multiplied by a certain factor in each case will give the percentage, if 1 gramme of metal is used for the analysis. A simple table then, in which the weight of precipitate is the argument, is all that is needed to enable the analyst to read the result, and this, it would be thought, any analyst would prepare for himself if he had much work of the kind to do. In order to help him, however, Messrs. E. B. Atkinson and Co., of Hull, have provided an instrument like a large wall aneroid, with a radial index which can be turned round, and behind this are arranged the figures of the table. The range is limited to precipitates ranging in weight from 10 to 49 milligrammes by units. Taking, for instance, a precipitate of Mn_3O_4 weighing 0·039 (gramme?), he will find that the manganese is present in the proportion of 2·809 per cent. It is true these figures are printed very small and upside down, but they are there, and they are embellished with a bevelled edge plate glass front and a 9-inch back of wood stained red, and a spun brass rim. The instrument is called the Ebur calculator.

A paper on experimental investigations of the maintenance of vibrations, by C. V. Raman, has just been published as Bulletin No. 6 of the Indian Association for the Cultivation of Science. This account of original work is divided into six sections. Of these the first deals with a new form of Melde's experiment, in which, by placing the prongs of the fork inclined to the string, the vibrations characteristic of the transverse and longitudinal forms of the experiment are simultaneously maintained. The two vibrations were also produced at right angles to each other, and so yielded the Lissajou's figures for the octave. The second section is on small motions at the nodes of a vibrating string observed stroboscopically. The third section treats the amplitude and phase of oscillations maintained by forces of double frequency. Records of the motions are obtained by a beam of light falling on the string and then reflected in turn by (1) a fixed mirror, and (2) a mirror fixed on the prong of the tuning-fork. The fourth section deals with vibration curves maintained by a variable spring. This is shown to occur for the longitudinal form of Melde's experiment, when the period of the force is $\frac{1}{2}n$ times that of the string, where n is any integer. The fifth section is on the maintenance of compound vibrations by a simple harmonic force. The possibility of this follows from the previous section, and its experimental realisation is here described. The sixth section deals with transitional modes of vibration under variable spring. The bulletin contains twelve illustrative plates, representing in all thirty-seven photographic reproductions of the curves obtained and of the disposition of the apparatus employed. The whole forms a welcome addition to our knowledge of such vibrations and their special maintenance.

Some remarks on the subject of photography by artificial light were contributed by Mr. J. S. Dow at the meeting of the Illuminating Engineering Society on November 19. A number of photographs of lighting installations, some including figures of people, were exhibited, and it was explained that a photometric judgment of the "surface-brightness" of objects in the field of view proved a useful method of estimating the exposure. A good photograph should show both the objects in the room and the sources of light without halation, and this demands very careful exposure and development. Allusion was made to the difficulties of taking "snap-shots" by artificial light. This seems just possible by the light of such illuminants as the Moore tube, but is at present scarcely feasible in the case of most installations using incandescent electric lamps. The introduction of a very much faster plate may, however, enable even this to be done.

THE November issue of *The Journal of Physical Chemistry* contains papers by Mr. F. F. Fitzgerald on the electrical conductance of solutions in methylamine and ethylamine and on the fluidity of ammonia, methylamine, and sulphur dioxide, and the fluidity of certain solutions in these solvents. The former paper is remarkable for a series of curves of molecular conductance of potassium iodide and silver nitrate in methylamine, in which a maximum is reached in concentrated solutions, in addition to the usual maximum at infinite dilution; in the cases now recorded the two maxima are separated by a very strongly developed minimum, which is most pronounced at the higher temperatures. In ethylamine, a weaker ionising solvent, the maxima in concentrated solutions are equally pronounced, but the dilutions studied were not sufficient to reach the minimum, and the final maximum representing complete ionisation was quite inaccessible. These phenomena, which have been noted in several instances by Franklin and others, and probably depend on the autolytic conductivity of the salt in the more concentrated solutions, are of considerable importance in studying the theory of electrolytic conductivity.

A COPY has reached us of the current number of Merck's "Annual Report" upon recent advances in pharmaceutical chemistry and therapeutics. As former readers of the report will know, it emanates from the well-known Darmstadt chemical works, and aims at giving in an impartial manner new information likely to be of use to medical men and pharmacists. Only those drugs are discussed which have been introduced into therapeutics as a result of scientific research; "secret remedies" and scientifically questionable preparations are excluded so far as possible. The special articles upon groups of drugs, which are a feature of the work, are this year devoted to the glycerophosphates and to the digitalis glucosides and allied drugs. The first article is a good summary of our present knowledge of the salts of glycerophosphoric acid and their medical applications. In the second, the history, chemistry, and pharmacology of the complicated digitalin group are treated at considerable length, the article running to a hundred pages, and including what appears to be an exhaustive bibliography of the subject. Of the general sections, those on the cacodylates, salvarsan, sera and antigens, the hypnotic action of adalin, bromural, and veronal, and on the use of sterilised kaolin in the treatment of dysentery and cholera, are specially worthy of note. The report is quite up to the standard of former issues, and as a record of new therapeutic preparations and of new uses for drugs already known, will be found very useful.

IN *Engineering* for November 22 Prof. A. H. Gibson, of University College, Dundee, gives a brief summary of the results of experimental work on the resistance to the flow of air through pipes. From experiments made by Dr. J. H. Grindley and himself, it appears that any formula of the usual form—

$$dp = \frac{flv^2}{2gm}$$

only applies if the coefficient f is varied, not only with the physical condition of the interior surface of the pipe, but with its diameter, with the mean velocity of flow, with the mean pressure, and with the temperature of the air. Prof. Gibson proposes a new formula which he has tested against a large number of results by different experimenters. The practical form of the formula for cast- or wrought-iron pipes laid under normal conditions as regards jointing, &c., and for air at a temperature of about 65° F., is

$$dp = 0{\cdot}00000125 \frac{p^{n-1} v^n l}{6{\cdot}6^n d^{3-n}} \text{ lb. per sq. in.}$$

Here d and l are the pipe diameter and length respectively in feet, p is the mean absolute pressure of the air in the pipe in lb. per sq. in., and v is the velocity in feet per second; n has values as follows:—

Diameter, inches	3	5	7	9	12
n	1·83	1·81	1·79	1·78	1·77

The formula gives the drop in pressure with a high degree of accuracy. It may be rendered applicable to other temperatures by introduction of a coefficient K, the value of which depends on the values of n and of the temperature; a table of values of K is given from which it appears that at 32° F. K is 0·980 when n is 1·28, and is 1·052 when n is 1·85. At 180° F. K is 1·061 when n is 1·28, and is 0·865 when n is 1·85. K is unity for all values of n at 65° F.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR DECEMBER:—

Dec. 2. 18h. 55m. Mercury in conjunction with Jupiter (Mercury 0° 35′ S.).
7. 10h. 12m. Mars in conjunction with the Moon (Mars 4° 2′ N.).
8. 7h. 7m. Mercury in conjunction with the Moon (Mercury 6° 11′ N.).
,, 11h. 0m. Mercury in inferior conjunction with the Sun.
,, 20h. 55m. Jupiter in conjunction with the Moon (Jupiter 5° 7′ N.).
11. 14h. 46m. Venus in conjunction with the Moon (Venus 2° 42′ N.).
,, 18h. 17m. Uranus in conjunction with the Moon (Uranus 4° 15′ N.).
13. 3h. 38m. Venus in conjunction with Uranus (Venus 1° 36′ S.).
18. 8h. 0m. Jupiter in conjunction with the Sun.
,, 9h. 0m. Mercury stationary.
21. 10h. 29m. Saturn in conjunction with the Moon (Saturn 6° 12′ S.).
,, 16h. 45m. Sun enters Sign of Capricornus. Winter commences.
25. 4h. 24m. Neptune in conjunction with the Moon (Neptune 5° 25′ S.).
27. 21h. 0m. Mercury at greatest elongation W. of the Sun.
31. 14h. 0m. Earth nearest the Sun.

THE SOLAR MOTION RELATIVELY TO THE INTERSTELLAR ABSORBING MEDIUM.—In *Monthly Notices*, No. 9, vol. lxxii., Prof. W. H. Pickering has a note suggesting that the interstellar light-absorbing medium may consist of material, gaseous molecules, rather than being simply the æther, and should demonstrate any existing drift of the æther relatively to the sun. The existence of such molecules in space may be accounted for by their continual expulsion from the sun and stars, and it is obvious that, if the æther is at all capable of offering any resistance to the passage of such materials, the molecules would eventually take up the motion of the æther relative to the sun. Then to determine the motion of the resisting medium would be, in any case, to determine the relative motion of the æther. Owing to their very small density comets would be the most likely celestial bodies to indicate the existence of the resisting medium.

Assuming that the majority of comets really have elliptic orbits, and are therefore following the sun through space, the effect of a resisting medium would be to drag their aphelia to the rear of the sun, *i.e.* towards the anti-apex of the sun's path.

As bright comets probably owe their conspicuousness to the fact that they are surrounded by enormous, very tenuous envelopes of gaseous material, the resisting action should be more evident on them, and on plotting the aphelia of a number of comets Prof. Pickering finds that this is the case. The aphelia of the brighter elliptical comets do appear to concentrate in a particular region of the sky, and this anti-apex in regard to the resisting medium coincides pretty closely with the solar anti-apex. There are some inconsistencies still to be accounted for, but on the whole it would appear that these cometary aphelia are dragged to the rearward of the sun, thus indicating a drift of the resisting medium, and therefore of the æther, in regard to the sun.

OBSERVATIONS OF COMETS.—The *Comptes rendus* for November 11 (No. 20) contain reports, from many observatories, of observations of comets 1912*b* (Tuttle's) and 1912*c* (Borrelly's). M. Borrelly states that on November 3 the nucleus of his comet appeared to be asymmetrically placed in the coma, while M. Coggia on November 4 and 8 could detect no definite nucleus but only a gradual brightening towards the centre; in this he is confirmed by M. Esmiol, of the Marseilles Observatory. Generally the comet is reported as a round nebulosity, with a very indistinct or no nucleus, and no tail; during the early part of the month the magnitude was about 9 or 10, and according to the ephemeris it is now about two-thirds as bright, and will continue to decrease.

METEOROLOGY AT THE BRITISH ASSOCIATION.

THE leading feature of meteorological interest in the proceedings at Dundee was the joint discussion with Section M, Agriculture, on the application of meteorological information to agricultural practice.

Dr. Shaw said that the annual loss to this country through unfavourable weather might be put at 20,000,000*l.*, and as forecasts must ultimately be forecasts for the whole globe, the amount of the loss some portion of which meteorologists aimed at saving for the British Empire far exceeded the estimate mentioned. But apart from forecasts, which aimed at saving by preventive precautions, there was probably much to be done in increasing efficiency by the application of our present knowledge of climate. In this connection the meteorologist wished to learn from the agriculturist if he could make use of meteorological statistics, and in what form he wished the statistics to be presented to him. There were, moreover, certain questions the answers to which would render possible considerable economies, and perhaps save the aspiring farmer many disastrous experiences. Such questions were: "What is the effect of climate on crops?" "What deviations from the normal values of the meteorological elements constitute a good or bad farmer's year?" Mr. R. H. Hooker had made some progress towards providing an answer to the first question in his paper on correlation between weather and crops, and he himself had investigated the relation between autumn rainfall and yield of wheat. Recently also Unstead had reached interesting conclusions in connection with the world's wheat crop, the polar limit of which depended upon the accumulated temperature and the duration of daylight in the summer months.

Mr. Watt communicated some results which he had obtained for the connection between rainfall and temperature, and the yield of crops in Forfarshire. He found that a dry June and July were favourable to the potato crop, and warmth during that period was also desirable. For oats, however, a cool June was decidedly favourable.

Dr. E. J. Russell spoke of the effect of climate on plant life by direct action on the plant itself, and indirectly through its action on the quality and texture of the soil. Heavy rain washed out the nitrates in the soil, while hot dry weather and frost conserved them. At the end of the summer of 1911 the soil contained $3\frac{1}{2}$ times the usual amount of nitrates, but the heavy rains of the succeeding autumn and winter washed out nine-tenths of them.

Mr. R. M. Barrington, speaking as a practical farmer, testified to the great utility of local observations in conjunction with the reports of the Meteorological Office, and expressed the opinion that meteorology ought to be taught to every budding farmer.

On the Tuesday morning Prof. Turner gave an account of his investigation of periodicities in earthquake phenomena. He found evidence of a real period of about 15 months and indications of a period of 11·76 months, which was also found in the rainfall at Greenwich. He communicated also a paper by Mr. J. I. Craig, in which the author showed that Schuster's method of the periodogram and the method of correlation were practically identical.

Mr. E. M. Wedderburn gave an account of his investigations of the temperature conditions in the Madüsee in Pomerania and in Loch Earn. In both cases the temperature changes were found to be oscillatory and capable of explanation on the assumption that the motion of the water in the lake was in opposite directions above and below the level of maximum rate of change of density.

Miss White read two papers on the results for wind and temperature obtained at the upper air station at Glossop Moor during 1908, 1909.

She found that the average velocity of the wind changed from 5·0 m.p.s. (metres per second) at ground level (335 m.), to 11·8 m.p.s. at 1000 m., and to 13·6 m.p.s. at 2000 m. above mean sea-level. The velocities at all heights were greater in winter than in summer, and greater also for occasions when the surface pressure was below the average than for occasions when it was above. The rate of increase of velocity was greater for westerly than for easterly winds. At the surface it was approximately the same, 5 m.p.s. in both cases, but at 2000 m. altitude the velocity was 16 m.p.s. for westerly winds compared with 12 m.p.s. for easterly. On the average, the theoretical value of the gradient wind calculated from the pressure distribution was reached by the actual wind at an altitude of 650 m., or 300 m. above ground level.

In the second paper on temperature, the rate of fall with height was found to diminish from 8·5° C. per km. near the surface to 4·3° C. per km. at

2000 m. altitude. The height at which the mean annual temperature is 0° C. was found to be about 2100 m. The temperatures in the upper air were higher, both in winter and in summer, over regions of high pressure than over regions of low pressure.

Both papers contained much valuable and interesting information, and Prof. Petavel expressed the hope that they would be utilised by aviators. The probable conditions in the upper air could be forecasted from the surface conditions by using the average values given by Miss White.

The report of the joint committee on the investigation of the upper air contains the results obtained at Mungret College, Limerick, during the past year, from which it appears that the height of the stratosphere over Ireland is very nearly the same as it is over England and the Continent. In speaking on the report, Rev. W. O'Leary, S.J., who has conducted the work at Mungret College, expressed the desire felt by those engaged in this work for definite instructions as to the type of weather in which ascents might be made with a fair chance of the balloon and instruments being recovered.

A grant of 50*l.* was made to the committee for the extension of the work during 1912–13, when it is hoped that ascents will be made over the North Atlantic.

EDUCATION AT THE BRITISH ASSOCIATION.

THE presidential address was devoted to the consideration of the progress made in the development of an objective standard in education. It was therefore a departure from the type of address with which this section has been opened, and as such it marks a distinct stage in the evolution of the science of education. Prof. Adams's statement was distinguished by its moderation. He realises the difficulties, but is not unhopeful of their being overcome. Whether the psychologists will be quite happy about his statement that education has captured their subject is not quite certain, but, much as education owes to psychology, there can be little doubt that psychology is vastly in the debt of education. But we are only at the beginning of the scientific study of the problem of education, which, by reason of its special aims and restricted field, must ultimately acquire that definiteness which we recognise as belonging to the older sciences represented in the British Association.

Most closely connected with the subject of the presidential address was the meeting devoted to the psychological processes underlying reading and writing. A sectional committee had reported upon the subject and arranged for papers to be read. Mr. F. Smith dealt with the process as it takes place in the practised reader, and Mr. Dumville with the learner. Mr. Dumville's paper was in the main a defence of the so-called "Look and say" method of teaching to read —the method, that is to say, which deals with whole words first, leaving their analysis to the time when the learner has realised the meaningful character of the printed page and is anxious to get at it. The natural tendency to analysis comes out in the effort to deal with new word-forms, and the teacher may profitably act as guide. Miss Foxley's experiments had led her to the same conclusions as those reached by Mr. Dumville. Dr. Brown and Dr. Rusk followed with accounts of movement in writing. The pedagogical consequences of these analyses were not, however, discussed.

Friday's meeting was devoted to the burning question of the relation of the school to future vocation. Mr. J. W. Peck, until recently clerk to the Edinburgh School Board, gave a lucid account of the way in which his authority attempted to meet the vocational call in the evening continuation schools of the city. Out of the 17,000 folk between fourteen and eighteen years of age, 12,000 were actually reached by their scheme—a purely voluntary one, as they have not put into operation the compulsory powers vested in them by the Act of 1908. The freedom of choice left to the pupils produced a want of balance in their work; the subjects having a directly utilitarian value were unduly favoured. Thus only $2\frac{1}{2}$ per cent. took courses in civics, and only 10 per cent. pursued English studies. Mr. Peck favoured some form of compulsion, as only in that way would they reach the outstanding 5000, and a reasonable curriculum be ensured. Mr. Holland showed us some of the difficulties of relating education to vocation, at any rate in the day school. The division of labour was so minute in his own district that a man might spend his working life on making the ninety-fifth part of a shoe. How exactly the difficulty was to be overcome Mr. Holland was not quite clear, although he was convinced that school work should, and could, be made more meaningful to the pupils.

Miss Faithfull spoke with conviction against allowing education to be determined by vocation. Her plea was for a liberal education in the old-fashioned sense of that word. She would deny that a training could be both liberal and vocational. Her voice was, however, a solitary one. Miss Burstall, of the Manchester High School, was wholeheartedly in favour of giving a vocational turn to the education of girls. She had worked in that direction in her own school with unqualified success. School was no longer a bore to girls who had at one time chafed under the exercises which seemed to lead nowhere. Mr. Reid spoke of the question from the point of view of the engineer, and Mr. Ferguson told the section of the successful effort to "liberalise" the vocation of cardboard-box makers in the Bourneville works.

An interesting review of the present position of mathematical teaching was opened by Dr. T. P. Nunn, followed by Drs. Pinkerton and Milne, and Mr. Eggar. The first three speakers were at one in their defence of the attempt to humanise school mathematics, even at the expense of dexterity in dealing with complex mathematical expressions—at any rate, in the initial stages. Mr. Eggar voiced a doubt as to the position in geometry, and Prof. Silvanus Thompson supported him in saying that reformers had often gone too far —further than Prof. Perry himself ever intended. Both Prof. Thompson and Principal Griffiths felt that a definite mathematical quality had been weakened or lost in the abandonment of Euclid, and that this loss would continue until some adequate substitute had been found.

Scotch experience in the matter of leaving certificates was described by Mr. Strong and Mr. Donne, and the Scotch Education Department was attacked by Principal Sir J. Donaldson, who in a previous discussion had advocated individual liberty in the matter of spelling.

The section received various reports from committees on (1) school books and eyesight, (2) the curriculum and organisation of industrial and Poor Law schools, and (3) the overlapping between school and university. It is hoped that the "books and eyesight" report will be circulated very widely amongst education authorities. It is clear, too, that there is much that needs amending in our industrial schools, especially perhaps in those which are run on the subscriptions of the charitable, and are therefore less directly under public control.

MINUTE LIFE ON OUR SEA-BEACHES.[1]

IN thinking of a suitable subject on which to address you this evening, it naturally occurred to me that the fellows of the Linnean Society and their friends include both botanists and zoologists, and are all of them, I hope, good field naturalists, who delight in work in the open. So I have decided to talk about what I am coming to regard as a somewhat neglected field of investigation, namely the minute life of our ordinary sea-beaches and the changes which that life undergoes throughout the year. Many biologists are inclined to regard an ordinary sandy beach as a very uninteresting collecting ground, where, they would say, there are but few living things to be found—perhaps some burrowing worms, such as Arenicola, some heart-shaped urchins, like Echinocardium, some lamellibranch molluscs, Solen, Mya and the cockles, and that is about all that most collectors would bring back from such a beach; and we have all heard fishery experts exclaiming at the poverty of such coasts in eloquent words. "Oh, the barren, barren shores which might be cultivated so richly!" is the burden of their cry. There is some truth in it. But if I am able to show that they are not so barren as is supposed, that only makes it the more likely that the beaches might be cultivated with advantage for the benefit of man.

FIG. 1.—A Lancashire mussel skear.

The amount of living things, both plants and animals, that can grow or may be reared in suitable localities between tide marks is astonishing. Let me show you a few photographs exhibiting life in profusion, both in its natural wild state and also under artificial cultivation, as examples of characteristic views on our coasts. Some show patches of the littoral zone near low tide mark, with in some cases huge colonies of the fleshy coral Alcyonium, and numbers of sea-anemones, of worm-tubes, and of zoophytes; in other cases masses of the larger algæ, Fucus and Laminaria; and then again some have the molluscs, Patella, Purpura, and Littorina, covering almost every available inch of the ground. Other more rocky shores, such as Bradda Head at the south end of the Isle of Man, have the stone so closely infested with Balanus, the acorn-shell, that for hundreds of yards it looks at low tide, from a distance, as if a broad, uninterrupted horizontal band of white had been painted on the rock, and on going close up to such a cliff one sees that for many yards in succession it is difficult to find a spot of exposed stone on which to put a finger.

Then, as an example of what could be done by cultivation, even of the rudest kind, we may look at these photographs of the mussel skears on some parts of the coast of Lancashire (see Fig. 1), where the shellfish soon become so closely crowded that, unless thinned out, they prevent each other's growth by their mutual pressure.

These organisms, however, are all large, common, and well known, while what I desire to bring before you as a neglected field is the presence of minute and little-known organisms which appear in profusion in some localities, at any rate on certain occasions, and are probably of enormous importance in their influence on the life of larger forms, both on the shore and at sea. Probably many, if not all, seashores would show the phenomena I wish to refer to, but the beach which I take as my example is that at Port Erin, in the Isle of Man, where between two rocky sides there is a flat expanse of sand with the usual barren appearance, and the usual burrowing annelids and molluscs.

The sandy beach has a steeper slope in its upper part, and at the base of this, not very far below high-water mark, and just where the damper, flatter, and less stony part of the sand commences, there are found from time to time throughout the greater part of the year larger or smaller greenish-brown patches, sometimes yards in extent, such as most naturalists would declare at a glance to be caused by accumulations of diatoms—and diatoms we at Port Erin at first supposed them to be. But one day last year on collecting a sample and putting it under the microscope I was astonished to find that the deposit was composed of an enormous quantity of minute, active, flagellate, yellow organisms, evidently belonging to the Dinoflagellata, and related to Peridinium (see Figs. 2 and 3).

FIG. 2.—Sand-grains and Amphidinium from the beach. Low-power.

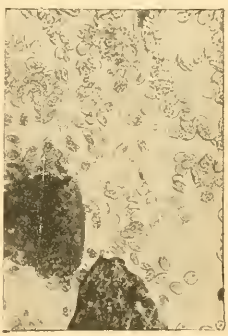


FIG. 3.—Part of Fig. 2 under high-power magnification.

[1] An address given at the Linnean Society's Reception on October 31 by Prof. W. A. Herdman, F.R.S

This organism proved on further investigation to be *Amphidinium operculatum*, Clap. and Lachm., which had never before been found in British seas, and very rarely anywhere else. And yet here it was in vast amount for weeks at a time[2]; and I am inclined to think it may be abundant on other beaches also. Several naturalists have told me since I mentioned this matter to the Linnean Society last year that they are convinced that they have previously seen Amphidinium patches on the shore, and had taken them for diatoms. But one of the most extraordinary points about the occurrence of this little Dinoflagellate is that it seems to alternate in time on the beach with almost pure cultures of certain common diatoms, such as *Navicula amphisbaena*, Bory, and *N. digito-radiata*, Greg. (see Figs. 4 and 5).

FIG. 4.—*Navicula digito-radiata.*

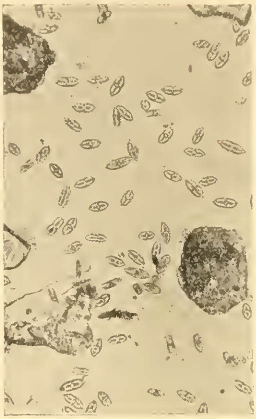


FIG. 5.—*Navicula amphisbaena* (?).

During 1911 the history of these coloured patches on Port Erin beach was as follows:—

April 7 to May 1.—Amphidinium and a few diatoms (Navicula).
June 3 to July 22.—Diatoms (some Navicula, others Pleurosigma).
September 9 and 10.—Amphidinium in abundance; diatoms absent.
September 16 to 18.—Diatoms (Navicula).
October 2 to 26.—Amphidinium in abundance; diatoms absent.
October 28 to November 1.—No Amphidinium present.
November 2. Amphidinium (three small patches).

During the remainder of the winter no patches were found, but by the beginning of April Amphidinium had reappeared in force and monopolised the beach for a couple of weeks. It was then replaced by diatoms for a few days, and in the latter part of April, 1912, the alternation took place no fewer than four times, ending with a couple of weeks in May, when neither organism was present. Amphidinium reappeared on May 15, and was present more or less during the greater part of the summer, except in the drier intervals of July and August, when it was absent. From September 14 onwards it has again been present in larger or smaller patches, and I have examined living samples sent from Port Erin, up to the last day of October; but, curiously enough, the individuals in these recent gatherings differ considerably in shape, size, and some other minor points from the *Amphidinium operculatum* we had been examining in such quantity at Port Erin during the previous year.

I am not of opinion as yet that this difference indicates more than a form of the same species—possibly seasonal or due to age or nutrition, or some other environmental influence; and the variation does not affect the broad phenomenon of the striking alternation of the two very different kinds of organisms, diatoms and Dinoflagellates, in vast quantity. Although it may not be possible yet to give any detailed explanation, the facts seem to point to the probability that the cause of the phenomenon is a physiological one, and that the explanation may consist in showing that each organism in turn in its metabolism exhausts or alters some essential constituent of the environment, so as to prevent its own continued existence, in quantity, at that spot, but leaves the ground suitable, or even favourable, to the physiological needs of the other set of competing organisms.

FIG. 6.—Copepod zoo-plankton from summer gatherings.

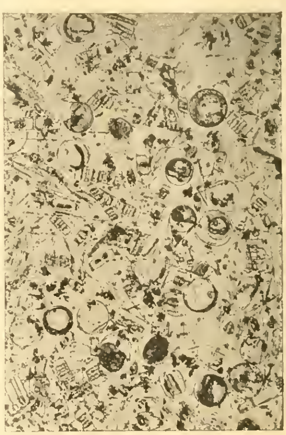


FIG. 7.—Diatom phyto-plankton from spring gatherings.

I owe all the photomicrographs to the skill of my friend Mr. Edwin Thompson.

Possibly we have a similar phenomenon on a more extended scale in the well-known seasonal variations of the plankton of the open sea, where during spring and summer the main constituent groups of organisms are Diatoms, Dinoflagellates, and Copepoda, succeeding one another in that order. (Figs. 6 and 7 show

[2] See Journ. Linn. Soc., vol. xxxii., No. 212, October, 1911.

a spring phytoplankton and a summer zooplankton gathering.) Prof. Benjamin Moore has recently found[3] a noteworthy change in the chemical reaction of the sea water round our coasts at different seasons of the year, no doubt in co-relation with the development of the plankton organisms. In spring (April) the water, not only on the shore, but out at sea, is acid to phenolphthalein, while in summer (August) it is distinctly alkaline to the same indicator. This change signifies an enormous conversion of carbon in the inorganic into carbon in organic form, a turn-over of colossal extent amounting to between 20,000 and 30,000 tons of carbon per cubic mile of sea water, or, if we think of the carbon as being in the bodies of living organisms, then the weight of these organisms will amount to about ten times that quantity of carbon in the cubic mile—or, if we imagine it occupying the deepest part of the Irish Channel, say, 300,000 tons of organisms per strip of water ten miles long by one mile broad and eighty-eight fathoms deep, all supplied with their necessary carbon from the carbon dioxide present in the sea water in spring.

Thus we can be led on from the simple observation of minute organisms on the beach to some of the greatest problems in the metabolism of the ocean; but the naturalist investigator need not necessarily venture out to sea in his quest. There is plenty of useful work to be done on the beach in carefully examining with the microscope the various deposits, such as sand and mud, found between tide marks, not once for all, but periodically, so as to determine the nature of the minute animals and plants, their relative abundance, and their variations, seasonal or otherwise, in quantity and character throughout the year. We know that some of these organisms, although individually insignificant, may exist in such quantities as to discolour the sands or the sea water, and even give rise to plagues amongst shellfish and other more directly valuable animals. Invasions of this kind, due to Dinoflagellata closely allied to our Amphidinium, are known to have appeared in America and in Australia, and possibly elsewhere. It is work worthy of the best endeavours of some of the younger botanists and zoologists of the Linnean Society, who have ready access to the coast, to try to extend our knowledge of the range and life conditions of some of those remarkable organisms—organisms which not only present scientific problems to the field naturalist, the cytologist, the experimental biologist, and biochemist, but, moreover, may well, from their vast numbers and sudden changes, have a profound effect upon the metabolism of the ocean, and so upon the prosperity of sea-fisheries.

[3] In the course of a Percy-Sladen Trust research upon the nutrition of marine animals, the detailed results of which will be published at an early date.

THE UNIVERSITY OF BRISTOL IN RELATION TO AGRICULTURE.

THE University of Bristol, the youngest of our universities, has made it evident that it intends to play an active part in the development of agricultural education and research. Some two years ago the University associated with itself the Royal Agricultural College, Cirencester, for purposes of higher education in agriculture, and arrangements for the granting of degrees in that subject are now being completed.

The Board of Agriculture and Fisheries has recently notified its intention of making an annual grant of 500*l.* to the college to enable it to provide for research on questions relating to forestry for the west of England area.

The University has also recently associated with itself the National Fruit and Cider Institute, which was established at Long Ashton, near Bristol, in 1903, to carry on investigations on fruit culture and cider-making. This institution has been supported since its establishment by annual grants from the Board of Agriculture and Fisheries, the county councils of Devon, Gloucester, Hereford, Monmouth, Somerset, and Worcester, and the Bath and West of England Agricultural Society. Its association with the University is the result of an offer on the part of the Board of Agriculture and Fisheries to the latter of an annual grant approximating to 2500*l.* to provide for the establishment of one of the agricultural research institutions contemplated by the Board in connection with the grant from the Development Fund available for the promotion of agricultural research.

The special subject of research allotted to Bristol is that of fruit-growing, including the practical treatment of plant diseases. The offer of the Board was conditional on the National Fruit and Cider Institute being made the centre at which the work was to be carried on. In connection with the scheme a capital expenditure of 10,000*l.* has been estimated to be necessary. Of this sum the Development Commissioners intimated their willingness to provide 50 per cent., provided that the remaining half was raised locally. Largely owing to the efforts of the Rt. Hon. Henry Hobhouse, chairman of the Somerset County Council, the necessary money has been subscribed. The expenditure is required for the purchase of land and the erection and equipment of laboratories and other buildings at Long Ashton. A department of agricultural and horticultural research has thus been created, Mr. B. T. P. Barker, director of the National Fruit and Cider Institute, being appointed head of the department and professor of agricultural biology in the University. Towards the upkeep of the department the University is contributing an annual sum of 300*l.*, the income of a gift from the late Lord Winterstoke for the purpose of agricultural research; and the income from other sources, including county council grants, is about 1500*l.*

The department of chemistry in the University is also taking part in the work. In the biochemical laboratory, investigations on the tannins of cider are proceeding in connection with the fruit research work. A special grant from the Development Fund for the continuation of investigations on the chemistry of Cheddar cheese, which have been carried out during the past two years by Dr. Nierenstein, has been promised. This work was begun in the first place at the request of the Somerset County Council, a grant for the purpose being given by that body.

The Board of Agriculture and Fisheries also proposes to make the University the centre for a group of the western counties in connection with its scheme for the provision of technical advice to farmers. The group will probably include Gloucester, Hereford, Somerset, Wiltshire, and Worcester, and possibly one or two other adjoining counties for special purposes. An annual sum of 1000*l.* is provided by the Board for this work. Under this scheme investigations on problems of local agricultural importance will be undertaken. In this connection reference may be made to the work on the "teart" or scouring land of Somerset, which has already been conducted by Mr. C. T. Gimingham for the past two years.

The following appointments to the staff of the Department of Agricultural and Horticultural Research have already been made:—Mr. A. H. Lees as plant pathologist, Mr. C. T. Gimingham as agricultural chemist, and Mr. Otto Grove, for some time assistant to Dr. Alf. Jörgensen, of Copenhagen, as enologist. A mycologist will be appointed in due course. In the biochemical laboratory Mr. Arthur Geake has been appointed research assistant to Dr. Nierenstein for the investigations on the chemistry of Cheddar cheese, and Mr. C. W. Spiers research assistant for the cider tannins investigation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The council of St. John's College has offered to the University 500*l*. as a contribution to the equipment of the Solar Physics Observatory on its installation in Cambridge.

The special board for biology and geology has adjudged the Walsingham medal for 1912 to E. D. Adrian, for his essay entitled, "On the Transmission of Subnormal Disturbances in Normal and in Incompletely Recovered Nerve."

The Walsingham medal for 1913 is to be awarded for an essay embodying the results of original research on any botanical, geological, or zoological subject, zoology being understood to include animal morphology and physiology.

K. R. Lewin has, with the approval of the Vice-Chancellor, been appointed assistant to the Quick professor of biology, in succession to Mr. C. Strickland, who has resigned the post.

The General Board of Studies has appointed W. B. Hardy a University lecturer in physiology from January 1, 1913, until September 30, 1917.

N. Cunliffe has been appointed to the studentship in medical entomology lately held by G. Merriman.

It is proposed to confer the degree of Master of Arts, *honoris causa*, upon Sir Arthur Thomas Quiller-Couch, King Edward VII. professor of English literature, and upon Dr. John Read, assistant to the professor of chemistry.

OXFORD.—On November 26 the preamble of the statute abolishing the existing division into orders of the elected members of council was moved in Congregation by Prof. Geldart, and supported by the warden of Keble. It was opposed by Prof. Gotch and Mr. Ball, and rejected by 87 to 105. The statute will probably be reintroduced in another form.

At the same meeting of Congregation the preamble of a statute amending the constitution of Congregation by abolishing the qualification of residence, and providing that in future that body shall consist only of the teaching and administrative elements in the University and colleges, was moved by Prof. Geldart, and, in spite of the opposition offered by the master of Balliol and Mr. Ball (by the latter on the ground that it provided for the safeguarding of vested interests), was carried by 100 to 79. An objection felt in many quarters to this enactment is based on the fact that it will disfranchise such persons as those graduates engaged in scientific or other research who do not happen to be employed in teaching or administration within the University. It is understood that no amendment to admit such persons will be possible under the preamble as now carried.

THE office of Vice-Chancellor of the University of Sheffield, vacant through the retirement of Sir Charles Eliot, has been accepted by Mr. H. A. L. Fisher, fellow and tutor of New College, Oxford.

AMONG the bequests of Mrs. A. M. Jones (widow of Prof. Tom Jones, of Manchester, surgeon), who died on October 30, are 1000*l*. to the Victoria University, Manchester, in augmentation of the endowment of the Prof. Tom Jones memorial scholarship, and 500*l*. to the University College of Wales, Aberystwith, as an endowment for promoting the study of surgery.

AT the annual meeting of the court of governors of the University of Wales on November 22 a resolution, moved by Sir Isambard Owen, that steps be taken to secure representation in Parliament for the Welsh University was carried by seventeen votes to twelve. In moving his resolution, Sir Isambard said that if university representation is to be continued there is no doubt that the younger universities will all be agitating for privileges with the older universities, and there is a danger that Parliament will pool these younger universities with only one representative for each group. He held that it is necessary that the Welsh University should not be pooled with, say, Birmingham or Bristol, because the Welsh University is national and possesses distinct interests.

THE governing body of the Imperial College of Science and Technology has decided to combine all the mathematical work of the Imperial College, and of its integral parts, viz. the Royal College of Science, the Royal School of Mines, and the City and Guilds (Engineering) College, into one department, and to place the supervision of this department under a chief professor of mathematics. A special joint committee of the governing body and of the delegacy of the City and Guilds College has now been constituted in connection with the selection of a suitable individual for appointment to the chair. It is the intention of the governing body to make the appointment from a date during the current session, so as to enable the new organisation to be perfected before October next, when the work of session 1913–14 begins.

THE proceedings at the congress of the fifty-three universities of the Empire, which took place in London last July, were described in articles published in the issues of NATURE for June 13 and July 11 last (vol. lxxxix., pp. 385 and 477). The official record of the proceedings has now been published for the congress by the University of London Press, Messrs. Hodder and Stoughton, London, as a volume of 464 pages, the price of which is 10*s*. net. If the congress meets, as proposed, at recurring intervals of five years, reports such as that now available will serve excellently to record the steps in the future development of university ideals. Not only are the papers read at the congress by experts on university education included, but the speeches made at the various meetings are also reported.

THE calendar for the session 1912–13 of University College, London, which is now available, is full of interesting particulars of the manifold activities of this important constituent college of the University of London. The list of original papers and other publications from the various departments of the college, since the dean's report in the preceding calendar, runs to sixteen pages, and an examination of it shows that each faculty recognises fully the vital importance of research work. It is worthy of note that the new chemical laboratories have been begun, and will be ready in about a year's time. The equipment of the faculty of medical sciences has been improved by the provision of the new pharmacology laboratories by Mr. Carnegie. These laboratories will shortly be opened. The total number of students in the college during the session 1911–12 was 1679—1031 men and 648 women. Engaged in post-graduate and research work there were 286 men and 117 women. The faculty of science was chosen by 175 men and 135 women, and engineering was taken up by 104 men.

THE Department of Agriculture and Technical Instruction for Ireland has arranged that a limited number of scholarships and of teacherships-in-training, tenable at the Royal College of Science, Dublin, shall be offered for competition among Irish students of science and technology in 1913. The scholarships are of the value of 50*l.* per annum, and, in addition, entitle the holder to free instruction during the associate course. A teachership-in-training has similar advantages except that the maintenance allowance is 21s. per week for the session of about forty weeks. Candidates must be not less than sixteen nor more than thirty years of age on June 1, 1913, and will have to satisfy the Department as to their knowledge of English and of one other of the languages—Greek, Latin, Irish, French, or German. The competition will be confined to mathematics, experimental science, and drawing. Applications for admission to the examination must be made not later than April 30, 1913, on forms copies of which may be obtained upon application to the Secretary, Department of Agriculture and Technical Instruction for Ireland, Upper Merrion Street, Dublin, or to the Registrar, Royal College of Science, Upper Merrion Street, Dublin.

SOCIETIES AND ACADEMIES.

London.

Physical Society, November 8.—Prof. A. Schuster, F.R.S., president, in the chair.—H. R. **Nettleton**: A method of measuring the Thomson effect. The distribution of temperature down a conductor conveying an electric current and at the same time moving uniformly through two fixed temperature sources is investigated. The effect of the Thomson heat on the distribution is exactly similar to the effect of a small impressed velocity. This result was applied to mercury to measure the Thomson effect by comparing the alteration of temperature $\Delta\theta_1$ at a point near the middle of the gradient caused by reversing a current of C amperes with the alteration of temperature $\Delta\theta_2$ at the same point due to a flow of mercury of m grams per second. Without any approximation as to emissivity loss or magnitude of Joulian heat, $2C\sigma/ms = \Delta\theta_1/\Delta\theta_2$, where s is the specific heat of mercury and σ the specific heat of electricity. Working with currents of from 4 to 9 amperes and with flows of different magnitudes—but never exceeding 1 cm. per hour—consistent values of σ were obtained, the value at 61° C. being -1.52×10^{-6} calories per degree Centigrade per coulomb. The thermo-junctions, which were of iron and constantan, were fused through the glass tubes with inappreciable distortion.—F. W. **Jordan**: An improved Joule radiometer and its applications. The first part relates to improvements made in order to convert the original Joule convection apparatus into an instrument for the exact measurement of small steady rates of evolution or absorption of heat. These improvements consisted in (1) replacing the badly conducting glass enclosure and cardboard partition by others made of brass and copper; (2) replacing the uncertain and variable magnetic control of the movement of the vane in Joule's apparatus by the elastic control of a quartz fibre; (3) shaping the channels, in which the vanes moved, so that the angular deflection of the vanes was proportional to the rate of evolution of heat; (4) reducing the size, so that uniform temperatures of its various parts could be maintained by (5) placing the radiometer within a concentric brass tube to exclude all extraneous heat excepting that which might be directed through apertures in its side towards the radiometer. The sensibility of the instrument was measured and found to be equal to 0.52 mm. per microwatt, as measured on a scale at a distance of one metre from the mirror. Thus the instrument may be used for the measurement of feeble oscillating currents. To convert the apparatus into an instrument for the measurement of radiant heat it is suggested that the radiant heat be directed through a small rock salt or fluorite window in the side of a compartment on to a thin blackened metal disc supported centrally. Its use for the quick measurement of the heat given out by radium is also suggested. The second part relates to a suggested method of measuring the Thomson effect with this radiometer. The method hinges on an experiment described by the author in Nature, May 18, 1911.—Miss A. **Somers**: Note on the attainment of a steady state when heat diffuses along a moving cylinder. The paper dealt with the case of a column of mercury moving with uniform speed between two fixed temperature sources. The differential equation for the temperature within the column was stated and its solution given, and it was shown how the time of attainment of a steady state could be obtained from the latter. Dr. S. W. J. **Smith**: Thermomagnetic study of steel. Thermomagnetic measurements make it increasingly evident that the magnetic properties of steels are frequently those of mixtures of magnetic substances, each possessing characteristic properties, which contribute in a comparatively definite way to the properties of the material as a whole. In the case of a simple ferromagnetic substance, magnetising fields can be found in which the permeability variation with temperature is small except in the neighbourhood of the critical temperature. In such fields there is a marked peak in the permeability temperature curve for the substance. The explanation of this peak suggests that the phenomenon should be found common to all ferromagnetic substances. The paper shows that it is exhibited by the carbide of iron (cementite) in annealed carbon steels.

Mineralogical Society, November 12.—Anniversary meeting.—Dr. A. E. H. Tutton, F.R.S., president, in the chair.—Prof. W. J. **Lewis**: Ilmenite from the Lengenbach Quarry. Imbedded in the dolomite was found a minute crystal, irregular in habit, showing the forms 110, $10\bar{1}$, 100, 112, 111, 275. The best readings were obtained from pairs of faces of 101 and between them and faces of a prism, the corresponding angles being found to be 64° 47′ and 57° 33′ respectively.—Prof. W. J. **Lewis**: Multiple twin of cassiterite. Threefold twinning is well and regularly developed on opposite sides of the crystal, which consists of two main portions with twin axes all in one plane, and the triplets so formed are connected together in a somewhat irregular way. Further, some of the individuals are twinned along pyramid faces inclined to the general plane, so that the back of the crystal is unlike the front.—Arthur **Russell**: An account of the minerals found in the Virtuous Lady Mine, near Tavistock. The following species were met with:—Chalybite, in pseudomorphs after fluor and barytes, termed respectively "boxes" and "slippers" by the miners; marcasite in sheaf-like aggregates; mispickel in two modifications; anatase, on one crystal of which was found a small crystal of brookite, the only one seen by the author from this locality.—Dr. A. **Hutchinson**: Some graphical methods in crystallography and crystal optics. Diagrams of expressions involving sines, such as $\sin E = \beta \sin V$, are much simplified by taking log sines for coordinates, the result being a series of parallel straight lines.—Dr. A. **Hutchinson** and W. Campbell **Smith**: Labradorite from St. John Point, co. Down. The large fresh crystals of felspar, which occur in a basaltic dyke, have physical characters—specific gravity 2.706, extinction on 010 and 001 −23° and −11° respectively, refractive indices α 1·5598, β 1·5648, γ 1·5694—which agree closely with the position of the felspar in the plagioclase series given by its chemical composition, which is approximately represented by the formula 33Ab5Or62An.—Dr. G. F. H. **Smith**: Apparatus for preparing thin sections of rocks. A description was given of the apparatus recently made for the Mineral Department of the British Museum.—Russell F. **Gwinnell**: Calcite crystals from a water tank. The crystals, which were deposited during the dry summer of 1911 from water derived from a spring in the marlstone of Belton Park, near Grantham, Lincs., averaged 0·1 mm. in greatest diameter, and showed the unusual unit rhombohedron form 1011.

Zoological Society, November 12.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—H. R. **Hogg**: Some Falkland Island spiders. The paper was based on a small collection of spiders formed by Mr. Rupert Vallentin during a two years' stay in the Falkland Islands. Of some of the species there were a fair number of specimens, but they comprised only six species of spiders and one of the allied suborder Opilio. The species were all apparently new, but the genera were all to be found either in Patagonia, Tierra del Fuego, or the islands about Cape Horn. The ancestors of the spiders might all have been transported aërially at an early period, and therefore afforded no evidence for or against a former land-connection, but in the event of the latter there should be many more species. The Opilio might have been conveyed under the bark of floating trees.—G. A. **Boulenger**: Descriptions of three new fishes discovered by Dr. Spurrell in the vicinity of Bibianaha, near Dunkwa, Gold Coast, and presented by him to the British Museum.—Dr. H. Lyster **Jameson** and Dr. William **Nicoll**: Some parasites of the scoter duck (*Oedemia nigra*), and their relation to the pearl-inducing trematode in the edible mussel (*Mytilus edulis*).—F. F. **Laidlaw**: Dragon-flies from Borneo belonging to the subfamily Corduliinæ, and to the genera Disparoneura and Amphicnemis of the subfamily Agrioninæ, with an account of a number of new species.

Royal Meteorological Society, November 20.—Dr. H. N. Dickson, president, in the chair.—Dr. H. R. **Mill**: The unprecedented rainfall in East Anglia on August 26 last. The rain commenced in London between 1 and 2 a.m. on August 26, but the hour of commencement grew later towards the northward, rain not beginning to fall in Lincolnshire until after 7 a.m. The intensity of the fall increased rapidly over the whole area, the maximum being reached in a fall of 4 in. in four hours from 11 a.m. in the neighbourhood of Norwich. In the central area the rain fell without intermission for more than twenty hours, and at some points probably for twenty-four. The distribution of the rain was somewhat remarkable. There were two foci of maximum fall, both in Norfolk: the northern central south of Cromer with more than 7·50 in.; the larger central east of Norfolk culminating in about twenty square miles with more than 8 in. of rain in the twenty-four hours. About 1940 square miles in Norfolk and Suffolk had more than 4 in. of rain; the area with more than 2 in. of rain was at least 5800 square miles. The general rainfall of each of the counties was calculated for this day, and also for the various river-basins, and it appeared that during the twenty-four hours as much water was deposited on the land as would fall in normal circumstances in two or three months. Several very heavy falls of rain in one or two days which had been recorded in different parts of the country were considered, and it was shown that although more than 8 in. had fallen at Seathwaite, in the Lake district, on more than one occasion as the result of one or two days' rain, there was no instance of so large an area having more than 6 in. of rain in two days as occurred in East Anglia on August 26.—A. P. **Jenkin**: A three-year period in rainfall.

CAMBRIDGE.

Philosophical Society, October 28.—Dr. Duckworth in the chair.—Dr. **Duckworth**: Anthropometric data collected by Prof. Stanley Gardiner in the Maldive Islands. The anthropometric data collected by Prof. J. Stanley Gardiner during his expedition to the Maldive Islands and Minikoi relate to sixty-nine individuals. Analysis of the data shows that the islanders are very variable as regards their physical development. The men of Minikoi are on the whole more variable than the rest. They are shorter and their heads are rounder than is the case elsewhere. Addu Atoll, the most southern islet, is in contrast with Minikoi in this respect. The highest caste in Male has the greatest stature and the largest head-dimensions. High caste seems to be associated with a broader nose, though this relation is contrary to expectation. No trace of a genuine pygmy element can be detected in any of the groups measured. Three main sources of immigration into the Maldives and Minikoi are considered briefly.—R. H. **Compton**: Preliminary note on the inheritance of self-sterility in *Reseda odorata*. As discovered by Charles Darwin, certain individuals of mignonette are self-fertile, others self-sterile. Breeding experiments, though as yet incomplete, indicate that self-fertility is a Mendelian character, behaving as a simple dominant to self-sterility.—J. **Gray**: The effects of hypertonic solutions upon the eggs of Echinus. It was shown that the abnormalities which are invariably found in the first segmentation division of the hybrid *Echinus acutus* ♀ × *E. esculentus* ♂ can be induced in the normally fertilised eggs of *E. acutus* by treatment with hypertonic sea-water after fertilisation; similar solutions, however, do not affect the normally fertilised eggs of *E. esculentus* to anything like the same extent, such eggs being practically normal. On these results was based an explanation of the fact that whereas the eggs of *E. acutus* ♀ × *E. esculentus* ♂ show irregular mitoses, those of the reverse cross are normal.—G. R. **Mines**: *Pulsus alternans*.

PARIS.

Academy of Sciences, November 18.—M. Lippmann in the chair.—E.-L. **Bouvier**: *Dugastella marocana*, a new primitive shrimp of the family of the Atyideæ. A representative of a new fresh-water genus found in Morocco; it corresponds most closely to the Californian Syncaris.—M. **Imbeaux** was elected a correspondant for the section of rural economy, in the place of the late M. Arloing.—Paul **Montel**: Some generalisations of the theorems of M. Picard.—Th. de **Donder**: The invariants of the calculus of variations.—M. **Lémeray**: The principle of relativity and the law of variation of central forces. The law of variation with the square of the distance for the action between heavy points at rest may be deduced as a necessary consequence of the principle of relativity.—Ch. **Féry**: A dead-heat galvanometer with a moving needle. Each pole of the magnet is suspended between two pairs of flat bobbins so close together as to constitute practically one solenoid. The sensibility of a galvanometer mounted in this way was 1 mm. deflection at one metre for a current of 8×10^{-10} ampere; the resistance of the four bobbins in series being 2 ohms, and the time of oscillation fifteen seconds.—G. **Denigès** and L. **Chelle**: A new reagent for free and combined chlorine and bromine. Details are given of the application of a method described in a previous note, based on the use of fuchsine decolorised with sulphuric acid. Dealing with such small quantities of bromine as are found in certain natural waters, the method can be applied quantitatively; it is more delicate and rapid than the methods in current use.—J. B. **Senderens** and Jean **Aboulenc**: The ethereal salts derived from the cyclanols and the acids of the fatty series. Starting with the six lower members of the fatty acids and the alcohols *cyclo*hexanol and the three isomeric methyl*cyclo*hexanols, twenty-four esters have been prepared by the catalytic method described in an earlier paper. The physical properties of these esters are tabulated.—Jacques **Duclaux**: The specific heat of bodies at low temperatures. It is known that the specific heat of most substances diminishes rapidly at low temperatures; the author discusses the hypothesis that this reduction of specific heat is due to increasing polymerisation.—Daniel **Berthelot** and Henri **Gaudechon**: The photolysis of saccharose by the ultra-violet rays. A study of the effect of the wave-length of the ultra-violet light on the chemical changes produced.—R. **Fosse**: The transformation of an alcohol into the sulphide of peroxide by the action of sulphuretted hydrogen and of hydrogen peroxide.—J. **Tchougaeff** and B. **Orelkine**: Some complex compounds of platinous chloride with aminoacetal.—R. de **Litardière**: The formation of heterotypical chromosomes in *Polypodium vulgare*.—Maurice **Durandard**: The combined influence of temperature and of the medium on the development of *Mucor Rouxii*.—Marc **Bridel**: The presence of gentiopicrin in *Swertia perennis*. The biochemical examination has shown that this plant contains a glucoside hydrolysable by emulsin; this glucoside has been isolated in a pure state and identified with gentiopicrin.—J. **Wolff**: The biochemical function of the peroxydases in the transformation of orcin into orcein.—Pierre **Bonnier**: The late awakening of the bulbar centres. The bulbar nervous centres in newly born children often require stimulation to start their action. This defect can be remedied by a very slight cauterisation of the nasal mucous membrane. Several successful cases of the application of this treatment are cited.—Jules **Amar**: the laws of work; experiments on filing. A study of the work expended by a man during the operation of filing brass, with a statement of the best conditions for the maximum yield for given expenditure of muscular effort.—Charles **Nicolle**, A **Conor**, and E. **Conseil**: Intravenous inoculation of dead typhoid bacilli in man. The treatment is marked by the absence of any reaction or local pain, and by the production in the system of a notable amount of the typhoid antibody.—Auguste **Lumière** and Jean **Chevrotier**: The polyvalence of the anti-typhoid sera.—A. **Marie** and Léon **MacAuliffe**: The study and measurement of 100 French tramps.—De Montessus de **Ballore**: An earthquake of epirogenic origin probable in the neighbourhood of Michigan and Wisconsin.—M. **Bourée**: The vertical migration of bathypelagic animals.

BOOKS RECEIVED.

The Note-books of Samuel Butler. Selections, arranged and edited by H. F. Jones. Pp. xii + 438. (London: A. C. Fifield.) 6*s*. net.

Annuaire pour l'An 1913. Publié par le Bureau des Longitudes. Pp. vi + 707, &c. (Paris: Gauthier-Villars.) 2.50 francs net.

Memoirs of the Geological Survey. England and Wales. Explanation of Sheet 359. The Geology of the Lizard and Meneage. By Dr. J. S. Flett and J. B. Hill. Pp. viii + 280. (London: H.M. Stationery Office; E. Stanford, Ltd., and others.) 5*s*.

Nutritional Physiology. By Prof. P. G. Stiles. Pp. 271. (Philadelphia and London: W. B. Saunders Co.) 6*s*. net.

Plant Geography. By Prof. G. S. Boulger. Pp. viii + 136. (London: J. M. Dent and Sons, Ltd.) 1*s*. net.

University of London. University College. Calendar Session 1912–13. Pp. clxxiii + 574. (London: Taylor and Francis.)

Report on the Enquiry to bring Technical Institutions into Closer Touch and more Practical Relations with the Employers of Labour in India. By Lieut.-Col. E. H. de V. Atkinson and T. S. Dawson. Pp. v + 100. (Calcutta: Superintendent Government Printing, India.) 1*s*.

Les Actualités Médicales. Le Radium: son Emploi dans le Traitement du Cancer des Angiomes, Chéloïdes, Tuberculoses Locales et d'Autres Affections. By L. Wickham and P. Degrais. Pp. 96. (Paris: J. B. Baillière et Fils.) 1.50 francs.

How to Attract and Protect Wild Birds. By M. Hiesemann. Translated by E. S. Buchheim. Third edition. Pp. 100. (London: Witherby and Co.) 1*s*. 6*d*. net.

Handwörterbuch der Naturwissenschaften. Edited by E. Korschelt and others. Lief. 23, 24, 25. (Jena: G. Fischer.) 2.50 marks each.

Catalogue of the Serial Publications possessed by the Geological Commission of Cape Colony, the Royal Observatory, the Royal Society of South Africa, the South African Association for the Advancement of Science, the South African Museum, and the South African Public Library. With an Appendix containing a List of the Serials in the Bolus Herbarium of the South African College. Pp. 54. (Cape Town: South African Public Library.)

La Théorie de l'Aviation. Son application à l'Aéroplane. By P. Gastou. Pp. 31. (Paris: F. L. Vivien.) 1.50 francs.

Les Aéronefs sans Chutes. By A. Remacle. Pp. 89. (Paris: F. L. Vivien.) 1 franc.

Science from an Easy Chair. By Sir Ray Lankester. A second series. Pp. xiii + 412. (London: Adlard and Son.) 6*s*. 6*d*. net.

The Star Calendar for 1913, with Revolving Chart. By Mrs. H. P. Hawkins. (London: Simpkin and Co., Ltd.) 1*s*. net.

The Star Sheet Almanac for 1913. By Mrs. H. P. Hawkins. (London: Simpkin and Co., Ltd.) 6*d*. net.

Practical Physics. By A. McLean. Pp. xi + 402. (London: A. and C. Black.) 7*s*. 6*d*. net.

Metalwork and Enamelling. By H. Maryon. Pp. xiii + 327. (London: Chapman and Hall, Ltd.) 7*s*. 6*d*. net.

A New Algebra. By S. Barnard and J. M. Child. Part i. Pp. viii + 182. Parts ii. and iii. Pp. viii + 149–340. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*. each.

A Dictionary of Applied Chemistry. By Sir E. Thorpe and others. Vol. iii. Revised and enlarged edition. Pp. viii + 789. (London: Longmans and Co.) 45*s*. net.

Questions on Newth's Inorganic Chemistry. By Prof. G. D. Timmons. Pp. 64. (London: Longmans and Co.) 1*s*. net.

Practical Measurements in Radio-activity. By Drs. W. Makower and H. Geiger. Pp. ix + 151. (London: Longmans and Co.) 5*s*. net.

An Introduction to Mathematical Physics. By Dr.

R. A. Houstoun. Pp. ix+199. (London: Longmans and Co.) 6*s.* net.

Yorkshire Type Ammonities. Edited by S. S. Buckman. Part viii. (London: W. Wesley and Son.)

The People's Books:—Hypnotism and Self-Education. By Dr. A. M. Hutchinson. Pp. 92. The Structure of the Earth. By Dr. T. G. Bonney. Pp. 94. Weather Science. By R. G. K. Lempfert. Pp. 94 Navigation. By W. Hall. Pp. 96. The Baby. By A University Woman. Pp. 94. Marriage and Motherhood. By H. S. Davidson. Pp. 94. (London and Edinburgh: T. C. and E. C. Jack.) 6*d.* net each.

Congress of the Universities of the Empire, 1912. Report of Proceedings. Edited by Dr. A. Hill. Pp. xlii+464. (London: Hodder and Stoughton.) 10*s.* net.

Primeval Man. By A. H. Quiggin. Pp. 140. (London: Macdonald and Evans.) 1*s.* 6*d.* net.

Sentinel Hours. By Prof. E. E. Speight. Pp. viii+261+plates. (London: A. and C. Black.) 2*s.*

The South Pole. By R. Amundsen. Translated by A G. Chater. Vol i., pp. xxxv+392+map. Vol. ii., pp. x+449+maps. (London: J. Murray.) Two vols., 2 guineas net.

A History of Geographical Discovery in the Seventeenth and Eighteenth Centuries. By E. Heawood. Pp. xii+475. (Cambridge University Press.) 12*s.* 6*d.* net.

Karakoram and Western Himalaya, 1909. An Account of the Expedition of H.R.H. Prince Luigi Amedeo of Savoy, Duke of the Abruzzi. By F. de Filippi. Pp. xvii+469+plates, and volume of Plates and Maps. (London: Constable and Co., Ltd.) Two vols., 63*s.* net.

The Beginner's Guide to the Microscope. By C. E. Heath. Pp. 119. (London: P. Marshall and Co.) 1*s.* net.

Herbals: their Origin and Evolution. By A. Arber (Mrs. E. A. Newell Arber). Pp. xviii+253. (Cambridge University Press.) 10*s.* 6*d.* net.

An Elementary Treatise on Coordinate Geometry of Three Dimensions. By Dr. R. J. T. Bell. Pp. xviii+381. (London: Macmillan and Co., Ltd.) 10*s.* net.

Mixed Metals or Metallic Alloys. By A. H. Hiorns. Third edition. Pp. xx+469. (London: Macmillan and Co., Ltd.) 6*s.*

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 28.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Earthed *v.* Unearthed Neutrals on Alternating Current Systems: J. S. Peck.

CONCRETE INSTITUTE at 7.30.—Bills of Quantities for Reinforced Concrete Work: John M. Theobald.

SATURDAY, NOVEMBER 30.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Some Letters from the Rev. Wm. Derham, Rector of Upminster, Essex, to Dacre Barrett of Belhus, Essex (1704–1710) Communicated, with Remarks, by T. Barrett-Lennard.—The Mycetozoa: Miss Gulielma Lister.

MONDAY, DECEMBER 2.

RÖNTGEN SOCIETY, at 8.15.

ROYAL SOCIETY OF ARTS, at 8.—Methods of Economising Heat: C. R. Darling.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—New Apparatus for the Examination of Mine Air: L. A. Levy.—Slate Bed Treatment of Sewage: W. J. Dibdin.

ARISTOTELIAN SOCIETY, at 8.—Purpose and Evolution: A. Lynch.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Geographical Results of the Abor Expedition A. Bentinck and Capt. Beauchamp Duff

SOCIETY OF ENGINEERS, at 8.—The Deflection of Reinforced Concrete Beams: P. J. Waldram

TUESDAY, DECEMBER 3.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion*: Mechanical Handling of Coal for British Locomotives: C. J. B. Cooke.—*Paper:* The Vibration of Rifle Barrels: F. Carnegie.

ILLUMINATING ENGINEERING SOCIETY at 8.—Modern Methods of Indirect Lighting: Their Advantages and Merits: F. W. Willcox and H. C. Wheat.

WEDNESDAY, DECEMBER 4.

ROYAL SOCIETY OF ARTS, at 8.—The Manufacture of Sugar from Wood, and its Economic Importance: A. Zimmermann.

GEOLOGICAL SOCIETY, at 8.—The Lower Palæozoic Rocks of the Cautley District Dr. J. E. Marr.—(1) The Trilobite Fauna of the Comley Breccia Bed (Shropshire); (2) Two Species of Paradoxides from Neves Castle (Shropshire): E. S. Cobbold.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Value of the Guaiacum Test for Bloodstains: H. S. Shrewsbury.—The Detection of Adulteration in Linseed Oil. G. D. Elsdon and H. Hawley. The Determination of Nitrates and Nitrites in Sewage Effluents: A. Higginson.—The Estimation of Citric Acid and its Separation from Tartaric and Succinic Acids: L. Gowing-Scopes.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, DECEMBER 5.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Physiological Observations made on Pike's Peak, Colorado, with Special Reference to Adaptation to Low Barometric Pressures: C. G. Douglas, Dr. J. S. Haldane, Y. Henderson and E. C. Schneider.—Notes on the Life History of *Trypanosoma gambiense*, with a Brief Reference to the Cycles of *Trypanosoma nanum* and *Trypanosoma pecorum* in *Glossina palpalis*: Muriel Robertson.—A Gregarine *Steinina rotundata*, nov. sp., present in the Mid-gut of Bird Fleas of the Genus Ceratophyllus: Dr. J. H. Ashworth and Dr. T. Rettie.—(1) The Size of the Aorta in Warm-blooded Animals and its Relationship to the Body Weight and to the Surface Area expressed in a Formula; (2) The Size of the Trachea in Warm-blooded Animals and its Relationship to the Weight, the Surface Area, the Blood Volume and the Size of the Aorta: Prof. G. Dreyer, W. Ray, and E. W. A. Walker.—Studies of the Processes operative in Solutions. The Conversion of Ammonic Cyanate into Urea, especially as Influenced by Alcohols: E. E. Walker.—(1) The Hydrolysis of Cane Sugar by Dilute Acids; (2) The Hydrolysis of Cane Sugar by Sulphuric Acid, with a Note on Improvements in Polarimetic Apparatus; (3) The Hydrolysis of Methylic Acetate by Acids: F. P. Worley.—The Nature of Hydrolytic Process: Dr. H. E. Armstrong and F. P. Worley.—The Direct Production of Characteristic Röntgen Radiations by Kathode Particles: Dr. R. T. Beatty.—The Penetrating Power of the γ Rays from Radium C: A S. Russell.—The Photo-electric Behaviour of Iron in the Active and Passive State: Dr. H. S. Allen.—A Determination of the Radiation Constant. H. B. Keene.

LINNEAN SOCIETY, at 8.—Notes on Two Orchids New to East Sussex, and on several Rarer Species of Orchidaceæ: E. J. Bedford.—The Hebridean Diagona described as "Syntethys," and other Exhibits from the Cruise of the S.Y. *Runa* in 1912: Prof. W. A. Herdman.—Nature Camera Work, an Attempt to Combine Photography with Drawing in Body-colour: Miss Maud Umfreville Clarke.—Coloured Drawings of South African Plants: Miss Mary W. Johnstone.

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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THURSDAY, DECEMBER 5, 1912.

THE METABOLISM OF LEPIDOPTEROUS PUPÆ.

Die Assimilationstätigkeit bei Schmetterlings-Puppen. By Prof. Gräfin von Linden. Pp. 104+iii Taf. (Leipzig: Veit and Co., 1912.) Price 4.50 marks.

THE phenomena of insect metamorphosis have been widely studied in this country from the point of view of morphology; the physiological aspects of the process have in comparison met with little attention. Several foreign observers have devoted themselves to the investigation of various questions relating to the exchange of material during growth and development in insects, the species usually selected being the common silkworm-moth of commerce. Results of considerable interest have followed from these researches; and, as the author of the treatise before us remarks, a wide field is thereby opened for further physiological investigation.

The Gräfin von Linden has put together in connected form the outcome of her own experiments, conducted from 1906 to 1911, on gas-exchange in lepidopterous pupae. To these records she has added an account of the investigations of other workers, summarising the whole in a concluding chapter, and giving her own interpretation of the facts and figures derived from these various sources.

The species experimented on by the author were the "scarce swallow-tail" (*Papilio podalirius*), the spurge hawk-moth (*Sphinx euphorbiae*), the pine eggar (*Lasiocampa pini*), the small tortoiseshell (*Vanessa urticae*), and the "small magpie" (*Botys urticata*). In all these it was found that in an atmosphere charged with CO_2, CO_2 was absorbed and O_2 might be given off. The insect, like the plant, uses light-energy to bring about the decomposition of CO_2 and the consequent liberation of oxygen. It was also found that under similar conditions the pupæ could take up nitrogen from the air, and thus increase their nitrogenous constituents. The insects experimented upon took up from the atmosphere, according to the author, carbon, nitrogen, hydrogen, and oxygen, and, even when no other source of nutriment was open to them, they were thus able, not only to repair loss caused by respiration, but also to build up new organic substances. This, she remarks, recalls the assimilatory process in plants. The resulting materials were protein, fat, and carbohydrates.

Of external influences favouring the absorption of CO_2, light, especially the rays of low refrangibility, is the principal in insects as in plants. Temperature has also a strong influence. High temperatures stimulate the respiratory process, so much so that even under otherwise favourable conditions of light the assimilatory process is masked. Another important factor is the degree of CO_2 concentration in the atmosphere, a high amount of CO_2 in the air hindering, especially in active larvæ, the respiratory process, and correspondingly favouring assimilation. Lastly, the humidity of the atmosphere has a strong effect in promoting CO_2 absorption.

The Gräfin's results on the assimilation of atmospheric nitrogen are of special interest to physiologists. In almost all her experiments with pupæ a taking up of nitrogen was observed; in larvæ, an alternate taking up and giving out. Where there was a regular assimilation of nitrogen it was dependent on light; the same occurred in plants. This, she says, seems striking, in view of the fact that most plant-physiologists deny assimilation of atmospheric nitrogen except by the help of bacteria. But it is less remarkable in the case of pupæ, because the absorption of nitrogen is already known to take place under starvation in very diverse animals (Regnault and Reiset).

The author believes that not only in an artificially CO_2-laden atmosphere, but also under normal conditions, the assimilation of CO_2 by pupæ may take place; supporting this view by citation of the results obtained by Kellner, Urech, Dubois, Couvreur, and others. Space will not permit of a full statement of her conclusions, which are certainly unexpected, and in some particulars revolutionary. Certain obvious criticisms must also be forgone. But her treatise is an arresting one, and the subject undoubtedly calls for fresh investigation.

F. A. D.

SYLVESTER'S MATHEMATICAL PAPERS.

The Collected Mathematical Papers of James Joseph Sylvester, F.R.S. Vol. iv. (1882-97). Pp. xxxviii 756. (Cambridge University Press, 1912.) 18s. net.

THE longest items in this final volume are the "constructive theory of partitions," published in *The American Journal*, and the lectures on reciprocants. The first of these is more consecutive than the notes on Sylvester's King's College course printed in a previous volume; perhaps, for this very reason, it is not quite so interesting. But his use of graphs is most ingenious, and the occurrence of Farey series in this connection may be specially noted. It is a rather curious fact that at the end of Art. 17 (pp. 15–16), Sylvester says that he has not proved a

P

theorem there stated about resolving N into sets of sequences. The theorem actually follows from the most elementary considerations; the only reason that can be suggested for Sylvester missing the proof is that he failed to note a one-one correspondence between two arithmetical expressions for sets of numbers.

The lectures on reciprocants aroused great interest at the time of their delivery, and the subject was taken up by English mathematicians with considerable vigour. Here, as in other cases, Sylvester had to suffer for his neglect of current mathematical literature. It was pointed out with truth, but unnecessary acrimony, that the whole theory of reciprocants was a mere particular case of Lie's transformation-theory; with this, and even with Halphen's papers on differential invariants, Sylvester seems to have been practically unacquainted until his attention was directed to them. Still more remarkable is the fact that he makes no allusion to Cockle's papers on criticoids. However, his work on reciprocants is permanently valuable, as giving a calculus of differential invariants analogous to that employed in the case of algebraic forms. Dr. Baker points out (p. xxxiii) that Sylvester was familiar with the idea of infinitesimal transformations; this, of course, is quite true, but he does not explicitly construct a theory of *groups* of such transformations, although his results constantly depend on the existence of such groups.

There are many brief notes of a stimulating character, such as those on matrices, on the distribution of primes, and on Goldbach's theorem. The theorem of Goldbach (or Euler) is to the effect that every even number, $2n$, can be expressed in at least one way as the sum of two odd primes. Sylvester adds, on the strength of experiment, that in at least one such representation, supposing n is composite, each of the primes will lie between $n/2$ and $3n/2$. On this assumption he makes a remarkable first step towards the proof of the theorem; for if p, q, r, &c., are the odd primes between $n/2$ and $3n/2$, it easily follows that the power-series equivalent to

$$\left(\frac{1}{1-x^p}+\frac{1}{1-x^q}+\frac{1}{1-x^r}+\ldots\right)^2$$

must give, as the coefficient of x^{2n}, the number of compositions $2n=p+q$, if we reckon $(p+q)$, $(q+p)$ as different compositions when p, q are unequal. All that has to be done now is to show that the coefficient of x^{2n} does not vanish.

This volume, like its predecessors, illustrates Sylvester's power of attracting willing and devoted disciples. Thus Franklin, and more particularly Hammond, toiled ungrudgingly in the service of the master; and their services deserve cordial recognition and gratitude.

A single remark will show how much we are indebted to the editor, Dr. Baker, for his care in revision. Mr. Morgan Jenkins supplied no fewer than twenty-seven corrections of errors and misprints in the "construction theory of partitions"—that is, about one for every three pages. Probably Dr. Baker found others, and it is not at all likely that this memoir was exceptionally inaccurate. So the corrections involved in the four volumes run into many hundreds. We have only noticed one place where a note seems required and has not been added. On p. 358 it is said that "the extent is not altered by the operation of V"; this is only true if the operand contains the highest letter to the second or higher degree. Oddly enough, Sylvester immediately takes an example where V diminishes the extent!

The biographical notice gives an interesting account of Sylvester's life and character, and a judicious estimate of his mathematical work. In particular, it is pointed out how strictly he confined himself to what may be called combinatorial analysis; writing nothing on groups, for example, and never dealing with function-theory properly so called. In addition to the notice, we have a photogravure reproduction of the portrait which hangs in the hall of St. John's College, Cambridge, and an engraving of the obverse of the Royal Society Sylvester medal, which represents his face in profile.

G. B. M.

PHILOSOPHY OF NATURE.

(1) *Tierpsychologisches Praktikum in Dialogform.* By Prof. Karl C. Schneider. Pp. iii+719. (Leipzig: Veit and Co., 1912.) Price 16 marks.

(2) *Richtlinien des Entwicklungs- und Vererbungsproblems.* Beiträge zur allgemeinen Physiologie der Entwicklung. By Prof. A. Greil. Erster Teil: Principien der Ontogenese und des biogenetischen Grundgesetzes. Pp. iii+352. (Jena: Gustav Fischer, 1912.) Price 10 marks.

(3) *Alle Fonti della Vita.* Prolegomeni di Scienza e d'Arte per una Filosofia della Natura. By Dr. William Mackenzie. Pp. 387. (Genova: A. F. Formiggini, 1912.) Price 10 lire.

MODERN science supplies an abundance of material, such as the philosophers of the past could not have dreamed of, for the psychologist and the metaphysician to explore when the man of science has worked through it. This material is also remarkably prolific in suggesting new lines of philosophic thought, as the work of William James and Henri Bergson, for instance, has shown. It is significant, however, that the psychologist, in his search for the links that bind subject to object, and mind to nerve, and the metaphysician, in his attempts to solve the problems of reality, must still be either Platonist or Aristotelian—a necessary consequence this of the orthogenesis, so to say, of the human mind.

(1) It was a happy thought of Prof. K. C. Schneider to set in dialogue form the various lines of inquiry and points of view available for the fascinating subject of animal psychology. The nature of man's mind and the foundations on which it is built up are engrossing questions which can best be approached by experimental study of the lower forms of mentality. And the distinctive character of this dialogue is that each point discussed starts from an experiment. The conclusions to be drawn from such experiments must vary with the personal equation. For instance, in the case of the method of trial and error, one is apt to forget that it is, after all, the principal method of human reasoning even in its highest developments. The philosopher himself, if called upon to solve the problem which he sets before a cat or a dog in the shape of one of those labyrinthine boxes, well-named "Vexierkasten," such as Hobhouse, Thorndike, and Lloyd Morgan have traditionalised—a good specimen is reproduced on page 578 of the author's book—would proceed at once, or certainly *sub finem*, by the method of trial and error. That is the universal method of organic intelligence, which behaves throughout as if enclosed in a Hampton Court Maze of matter.

The Psychologist, the Monist, the Vitalist, the Physiologist, the Lamarckian, and the Darwinian, the persons of the dialogue, discuss all possible phenomena of perception, action and experience, from the amœba to the ape. Orientation and various tropisms lead up to the "mono-, bi-, and tri-polar hypotheses." The dreams and games of animals are well treated; the "speech of animals" is a suggestive chapter. The illustrations are apt; many are original. The book should be translated into English.

(2) Psychological problems are midway between biological and metaphysical. Prof. Greil in his first volume argues very thoroughly but with a great deal of repetition and rhetoric, with a wealth of abstract terms and with a poverty of experimental illustrations, in favour of Haeckel's principle of *epigenesis*. There are few more interesting lines of thought than those presented by ontogeny and phylogeny—for, whether it be that the organism is continually coming into new circles of environment throughout its existence, or that its changes are preordained by determinants, either or any hypothesis is at once in the metaphysical and the mechanical sphere. How to engineer even embryological developments, and how to rationalise the process and the result so as to satisfy the "logical principle," are as much mysteries as any the Schoolmen meditated. The author, professor of anatomy at Innsbruck, traces very lucidly the development of theory, from the old systematism, which started from anatomy, to the new *Entwicklungsmechanik*, which ends in enzymes and commences with chemical combinations and mechanical forces. He well criticises the "mosaic theory," but one wishes he could give us, so to say, the perspective of an orthogenic principle that would convince the mind. The volume has the defect of being entirely without headings to chapter or page—the author's name and the title of the book surmount each column of type, while the reader experiences difficulty in knowing where he is.

(3) Dr. W. Mackenzie writes in Italian a disquisition such as is increasingly abundant to-day on the principles, logical and metaphysical (in the older application of the terms), which may underlie the processes of organic life. This style of "philosophy of nature" is practically a modern form of neo-Platonism. The "idea" is pursued, with the help of analogies, chiefly suggested by morphology, from the "individualised" cell to the ethical and æsthetic Absolute inherent in the universe. "World harmony," the "omnipresence of the moral principle," the "artistic principle," and, behind them, the "logical principle," are merely impressions from the die in which our thought is formed. Such metaphysics, no doubt, will always be written and always illustrated by beautiful diagrams and coloured pictures. But this author cannot tell us what the "psychical and teleological energy" is; he expounds "biological unity," but gets no nearer to an explanation of the dynamical capacity of living matter. "Beauty arises from death," like similar pronouncements, is merely superficial. It is kinematography, not science, nor even metaphysics.

A. E. CRAWLEY.

OUR BOOKSHELF.

Zur Phylogenie der Primulaceenblüte. Studien über den Gefässbündelverlauf in Blütenachse und Perianth. By Dr. Salvator Thenen. Pp. iv+131. (Jena: Gustav Fischer, 1911.) Price 8 marks.

THE course of the vascular bundles in the perianth and floral axis has been studied by the author in a large number of species of the Primulaceæ. His results are described in this work, and are discussed in relation to some phylogenetic problems of the floral structure.

One of the chief objects of this research was to see how far the data obtainable would agree with Van Tieghem's view that five of the vascular bundles of the corolla represent the supply of a suppressed second whorl of stamens. The bundles in question traverse the tube of the corolla in an antisepalous position, and usually each of them forks into two just below the limb, the two branches then passing out into the adjacent lobes of the corolla so as to form lateral bundles in them. Van Tieghem regards the suppression of the stamen as having led to its vascular supply being utilised by the neighbouring lobes of the corolla.

The author has carefully traced the vascular bundles from the floral axis upwards into the two perianth-whorls. This has revealed the fact that, in those species which possess lateral bundles in the calyx-lobes, the origin of these bundles is precisely comparable to that of the lateral bundles of the corolla-lobes. In each perianth-whorl the lateral bundles are derived (and in a similar way) from the strands which become the median bundles of the lobes of the other perianth-whorl. Thus any theory applied to the origin of the lateral bundles of the corolla and inapplicable to the calyx gains no support from the course of the vascular strands.

A comparison of the different forms, including those with "staminodes," yields further data, which also appear to militate against Van Tieghem's theory, and to supply some interesting material relating to floral phylogeny.

(1) *New South Wales. Historical, Physiographical and Economic.* By A. W. Jose, T. Griffith Taylor, Dr. W. G. Woolnough. Edited by Prof. T. W. Edgeworth David, F.R.S. Pp. xii + 372. (Melbourne: Whitcombe and Tombs, Ltd., n.d.) Price 4*s.* 6*d.*

(2) *Cambridge County Geographies: Radnorshire.* By Lewis Davies. Pp. xi + 156. *Renfrewshire.* by Frederick Mort. Pp. ix + 177. *Perthshire.* By Peter Macnair. Pp. xii + 180. *Dumfriesshire.* By Dr. James King Hewison. Pp. ix + 170. *North Lancashire.* By Dr. J. E. Marr, F.R.S. Pp. xii + 180. (Cambridge University Press, 1912.) Price 1*s.* 6*d.* each.

(1) THE interaction between the relief of the land and its climate, between the passive, or physiographic, factors and the active, or human, factors in the development of the life of a country is strikingly illustrated by this book on New South Wales, which summarises the latest information regarding that region. The student, who has hitherto had to search through the volumes of various scientific societies for his facts, will be grateful to the authors, not only for this concise summary, but also for the coherence with which the facts have been collated. The treatment of climate and that of the development of the physical features of the country seem the most valuable parts of a thoroughly sound exposition.

(2) The well-known features of the Cambridge County Geographies are preserved in the new volumes. It remains but to mention points of special interest. Radnorshire is strong regarding the agriculture and the military history of the county; Renfrewshire on the relationship between the county and the estuary of the Clyde; Perthshire includes a panorama of the mountains and a population map showing the influence of the valleys on the distribution of the people; Dumfriesshire has an interesting map connected with the place names of the locality; and North Lancashire emphasises the relation between the geology and the scenery of the county. Perthshire contains a map of the rainfall of Scotland by Dr. Mill, which differs, especially in the case of the Southern Uplands, from the more detailed map by Mr. Andrew Watt which is printed in the other volumes.

B. C. W.

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.*]

The Moon and Poisonous Fish.

MR. E. G BRYANT, in NATURE of November 14, asks a question regarding the effect of moonlight in "turning" fish. I have lived many years in South Africa, and have encountered the same belief, that moonlight will hasten the turning bad of fish; and at one time, when living at Muizenberg, I obtained some experimental proof of the moon's action on fish. It seems curious, at first sight, that moonlight, which has so little effect on meteorological instruments, should have this effect on fish. I have thought it probably due to insects or some low form of life which would be abroad, or be stimulated to action, on moonlight nights and not on dark nights.

The action of moonlight in stimulating the rise of sap in trees is widely believed in by practical wood cutters in almost every quarter of the world.

D. E. HUTCHINS.

Ridley, Kent, November 23.

What the British Caves might tell us.

WILL you kindly allow me, as one who has made considerable additions to our Pleistocene fauna, vertebrate and invertebrate, to support Mr. Hunt's appeal for the resurrection of that vast amount of material now stored away that was obtained in Kent's Cavern? Those of us who have paid attention to the subject are aware that the recorded lists give us but a poor idea of what the caves could tell us, and that from the waste dumps have been obtained a large number of new species, and even from the lowest layers these bones include those of man himself. In these circumstances we feel the time has come, not only for this material to be put into competent hands, but for the caves to be reworked on modern lines and in the light of recent research.

W. J. LEWIS ABBOTT.

THE APPLICATION OF OPTICAL METHODS TO TECHNICAL PROBLEMS OF STRESS DISTRIBUTION.

IT is interesting, in the study of experimental work on the properties of engineering materials, to trace the general trend of the design of apparatus for research, as the need of more accurate knowledge has arisen. Much of our fundamental knowledge of materials has been gained from the study of strains in wires, bars and beams, under uniform conditions of loading; and the experimental apparatus employed has generally made these conditions necessary. The bulk of the technical problems which still require solution are, however, those in which the internal stress varies enormously from point to point; and hence the strain-measuring apparatus now employed in researches has been so increased in delicacy that it is possible to obtain average measurements over very small distances which approximate, if they cannot reach, to the measurement of the strain at a point.

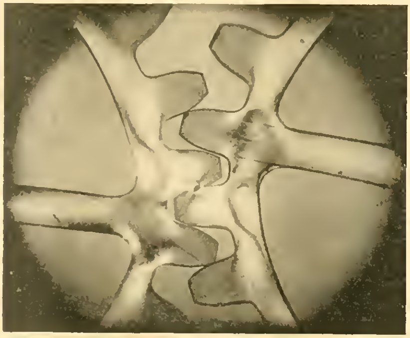

FIG. 1.—Transparent spur wheels in circularly polarised light.

Optical science has, however, provided a very perfect method for investigating the stress at a point, and the mathematical and physical investigations of physicists, among them Neumann, Clerk Maxwell, Mesnager and Filon, on the temporary double refracting properties of stressed glass have made it possible to enlist the aid of a valuable experimental means of studying internal stresses produced in models of structures and machines.

It is not necessary here to show that the stresses in glass of good optical quality agree very closely with the calculated values of the theory of elasticity. It is worth while, however, to point out that the apparent neglect of a valuable means of technical research has been due to almost unavoidable causes, the chief of which have been the great cost and fragility of glass specimens when shaped to forms adapted for investigations, and the necessity of employing very small models to suit the dimensions of the optical appliances available.

Some of these difficulties have been removed by the substitution for glass of one of the nitro-cellulose compounds now available. These compounds approach glass in the perfection of their optical properties, and are considerably superior in ductility, and in the ease with which the material can be fashioned into complicated shapes at a fraction of the cost of glass specimens. An example of this is afforded by the accompanying photograph, Fig. 1, of a pair of toothed wheels of transparent material shaped in a gear-cutting machine in exactly the same way, and as accurately as their metal counterparts. They are shown here under somewhat heavy loads; and the condition of internal stress is marked by colour fringes, which appear as black bands in the photograph.

An important feature of this kind of material is its ability to sustain stresses of as much as several thousands of pounds per square inch without injury, so that the double refraction produced by the loading can be made much more intense than in glass, which usually fractures at very small loads.

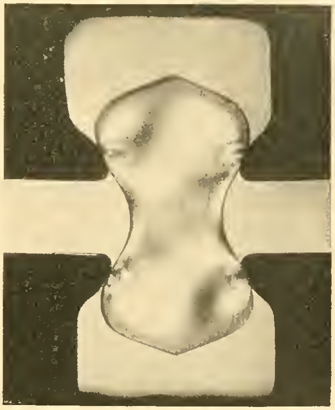

FIG. 2.—Model of cement briquette in plane polarised light.

The comparative rarity and great cost of large Nicol prisms have also restricted optical investigations to very small objects, but, as will be shown, this difficulty has been surmounted, and the size of the specimen illuminated by plane or circularly polarised light may be chosen at pleasure. Although not an essential feature, it may be mentioned that the brilliant colour effects of double refraction may be permanently recorded in a very convenient manner by any of the modern photographic plates now available.

In describing in general outline a method of obtaining the stress distribution in a loaded body, it may be useful to recall that a glass or celluloid body under stress causes an incident beam of plane polarised light to divide into two rays, which have different phases at exit, and also have their planes of vibration in the directions of the principal axes of stress in the body. A stressed object between crossed Nicols, therefore, shows dark bands or brushes, and these mark the positions of points in the body corresponding to definite inclinations of the principal axes of stress. If, for example, we take a transparent model of some stressed object, such as a cement briquette, Fig. 2, of the form used by engineers for testing the tensile strength of cements, we can observe the movements of the bands shown on this model as the Nicols are rotated, and can mark the positions of the axes of principal stress at every point in the specimen.

A series of positions of the central lines of these isoclinic bands is shown in Fig. 3*a* for this case, and from these curves we can readily obtain, by graphical or other processes, a map of the lines of principal stress (Fig. 3*b*) throughout the body. The isoclinic lines are especially valuable for verifying the results of mathematical calculations,[1] as only small loads need to be employed, thereby avoiding the fracture of costly glass specimens and the possible variation of the physical properties of the material at high stresses. In technical problems, however, and in cases where a mathematical solution is not available, it is generally advisable, and it may be necessary, to measure the intensity of the double refraction produced by load.

The colour fringes indicating the stress are observed more accurately with circularly polarised light as the isoclinic bands are then absent, and the difference of the principal stresses at a point can be obtained from a colour or a wave-length scale. A direct measure can also be obtained by stressing a simple tension member, set along one direction of principal stress, until the field is reduced to blackness at the point desired. This has the advantage of being a zero method, and is simple to carry out with ordinary mechanical appliances.

The problem of determining accurately the principal stresses separately is, in general, one of some difficulty, and a combined method depending on optical and thermo-elastic properties has been suggested,[2] but in many cases this may be accomplished fairly accurately by approximate methods, especially where one principal stress is very great compared with the other. In the present instance, the chief interest lies in the distribution of stress at the minimum section, where fracture is intended to take place. The minor principal stress at this section is small everywhere, and vanishes at the ends. Hence, the experimental curve of values of the difference of principal stresses at the section, Fig. 3*c*, also shows the tensions at the ends accurately, and very nearly so at other points.

If this stress curve is integrated and compared with the stress applied, a mean value of the minor principal stress may be determined, and an approximation to the minor principal stress distribution obtained. Even without this we can see that the stress across the section of a cement briquette probably varies very greatly, and that the universal method of reckoning the stress intensity, by dividing the total applied load by the cross sectional area, is inaccurate and misleading. Experiment shows also that models of the standard briquettes of Continental Europe, America and England differ appreciably in their stress distribution curves, and have, in fact, no common basis for the comparison of results.[3]

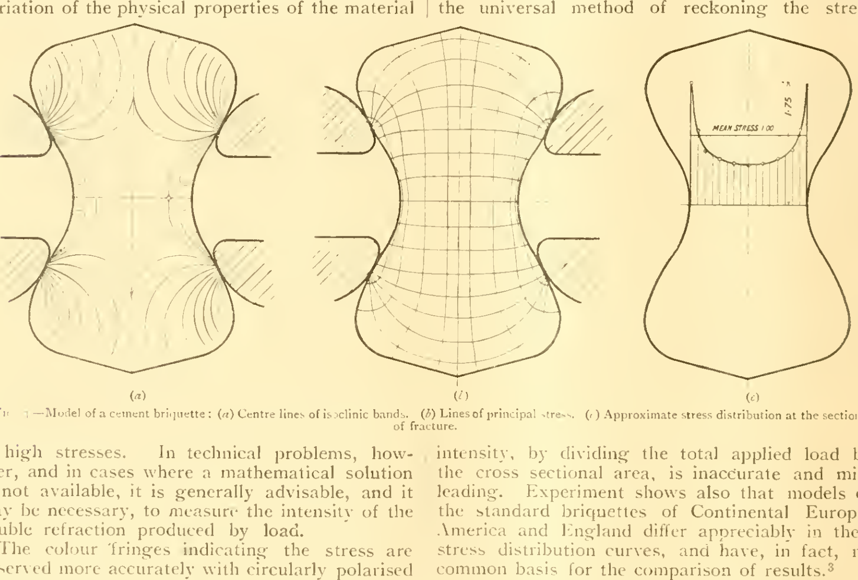

FIG. 3.—Model of a cement briquette: (*a*) Centre lines of isoclinic bands. (*b*) Lines of principal stress. (*c*) Approximate stress distribution at the section of fracture.

For examining models of structures and parts of machines it is usually essential to obtain a field of view in circularly polarised light far beyond the scope of the largest Nicol prisms and quarter wave plates hitherto constructed. In collaboration with Prof. Silvanus P. Thompson these difficulties have been overcome by the construction of polariscopes and quarter-wave plates of a size beyond any immediate requirements.[4]

One of these instruments is shown in cross-

[1] "The Investigation of Stresses in a Rectangular Bar by means of Polarised Light." By L. N. G. Filon, *Phil. Mag.*, January, 191 .

[2] "The Determination of the Stresses in Springs and other Bodies by Optical and Electrical Methods." By E. G. Coker, Brit. Assoc., 1912, and *Engineering*, September 20, 1912.

[3] "The Distribution of Stress at the Minimum Section of a Cement Briquette." By E. G. Coker, the International Congress for Testing Materials, New York, 1912.

[4] "The Design and Construction of Large Polariscopes." By Profs. E. G. Coker and S. P. Thompson, Optical Convention, London, 1912.

section by Fig. 4. Light from a bank of lamps, A, is diffused by tissue-paper screens, B, and afterwards reflected from a black glass plate, C, set

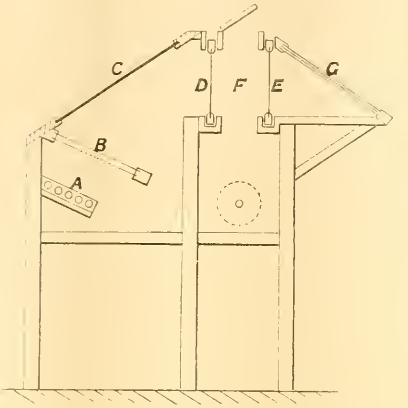

FIG. 4.—Cross-section of a polariscope for examining models of girders and ships.

at the polarising angle. Quarter-wave plates D and E are arranged to produce a circularly polarised field in the object space, F, and for demonstration purposes the analyser is constructed of thin glass plates, G, while a small Nicol prism is used for quantitative work. This apparatus, intended for models of bridge structures and ships, is capable of affording a clear field of view through quarter-wave plates of nearly a yard in length and a foot in depth, but so far no models of this size have been found necessary.

Polariscopes of a size adapted to show the whole of a model at one time appear to be essential for successful work in many instances. An example of their use is afforded by a determination of the distribution of stress in a long thin plate, A, Fig. 5, subjected to pure shear.[5] A plate of celluloid, 3/16 in. thick and 10 in. long, was rigidly clamped at the sides, B, and a maximum pull of about three tons was exerted by a centrally disposed weight, W, thereby affording a nearly pure shear over the free portions of the plate. The whole of the sheared area was visible in the field of view of the polariscope, and with the aid of a calibrating tension member the distribution of shear stress was plotted for different lengths of plate. The mean shear applied was 800 lb. per square inch in all cases, and the results show some interesting peculiarities. In a long thin plate the shear stress rises slightly in value from the centre to near the ends, and then rapidly falls to a zero value at the extreme edges of the plate. The maxima become more pronounced as the plate is shortened, until a critical length is reached, where the distribution changes to one with a central maximum and ultimately becomes parabolic in character with a large increase of intensity, as the final curve shows.

Another field of usefulness which suggests itself is the application of optical science to the design of structural members. If, for example, we take a model eye-bar of a type often used in suspension bridges and the lower chords of pin-connected trusses, we can readily obtain (Fig. 6a) a map of the lines of principal stress for this form, and their general resemblance to those obtained in a hook[6] at once suggests that across the principal section the stress is very badly distributed. It is apparently very intense at the eye and rapidly decreases until it ultimately changes to compression stress at the outer end of the section. Experiments now partly completed confirm this view, and they also show that another form (Fig. 6b) gives a much better stress distribution wholly tensional across the principal section, as the curves of principal stress indicate.

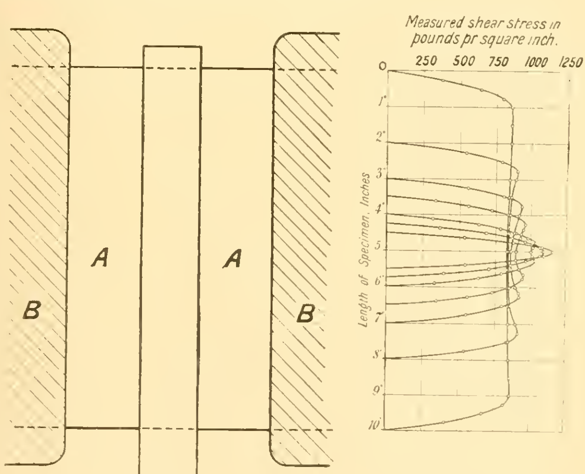

FIG. 5.—Distribution of stress in a long thin plate subjected to shear.

Both forms appear to restrict unduly the lines of stress where the head joins the main member,

[5] "An Optical Determination of the Variation of Stress in a Thin Rectangular Plate subjected to Shear." By E. G. Coker, Proc. R.S., vol. lxxxvi, 1912.

[6] "The Optical Determination of Stress." By E. G. Coker, *Phil. Mag.*, 1910.

and it is inferred that the head ought to merge more gradually into the main body of the member than is at present the common practice. The applications of optical science may possibly be of use, therefore, in the design of structures and machines, as these examples indicate, especially where new problems arise, such as in the design and construction of aeroplane stays and struts, where a poorly designed member adds weight without coresponding strength, and may by its failure result in a serious loss of life.

E. G. COKER.

(a) (b)

FIG. 6.—Lines of principal stress in two standard types of eye-bars used in bridge structures.

THE WARFARE AGAINST TUBERCULOSIS.

PROF. METCHNIKOFF delivered the Lady Priestley Memorial Lecture for 1912–13 under the auspices of the National Health Society at the Royal Society of Medicine on November 29. Sir Crichton Browne presided, and among others present were Sir Thomas Barlow, President of the Royal College of Physicians, Sir Rickman Godlee, President of the Royal College of Surgeons, Sir Ray Lankester, Sir James Goodhart, Sir Almroth Wright, Sir Lauder Brunton, Dr. and Mrs. Priestley, Sir Edward and Lady Busk, and Mr. and Mrs. Stephen Paget.

The subject of the lecture was the campaign against tuberculosis, and subjoined is a summary of Prof. Metchnikoff's remarks.

Although tuberculosis had been regarded by some as contagious, particularly in southern countries, it was a French observer, Villemin, who fifty years ago showed that the disease can be transmitted by inoculation. Then in 1881 Robert Koch discovered the causative germ, the tubercle bacillus. Several species, or at least strains, of the tubercle bacillus are known, and piscian, avian, and mammalian forms are now recognised, and the bacilli of man and of bovine animals also exhibit differences, but the variety peculiar to man is the great source of human tuberculosis.

Tuberculosis is a common disease, but does not kill rapidly, and may take months or even years before ending fatally. The bacillus causes the formation in the tissues of cellular nodules, the tubercles, in which large multi-nucleated cells, the "giant" cells, are present, and perform a defensive function, ingesting and destroying tubercle bacilli, so that in favourable cases the nodules heal and disappear, or become fibrous or calcareous and inert.

There is evidence that tuberculous infection is exceedingly frequent, for the healed or calcareous tubercles are very common at the apex of the lung of those dying from any cause, and can also be demonstrated by applying the Pirquet test. This consists in applying tuberculin to a scarified patch on the skin, which gives rise in tuberculous persons to an inflamed red spot, and 90 per cent. of the adult European population is shown in this way to have been infected with the tubercle bacillus, yet only 15 per cent. die of tuberculosis. Among the Kalmuk Tartars, studied by Prof. Metchnikoff, however, tuberculosis is rare, but this is not due to a natural insusceptibility, for Kalmuk youths residing in towns in Russia for purposes of education contract tuberculosis freely.

Attempts to cure tuberculosis by drugs, diet, climate, serum, and tuberculin were discussed, but the conclusion was expressed that, though some of these are helpful, no real remedy or sure treatment for tuberculosis has been found. Nevertheless, the death-rate from tuberculosis in large cities, such as London, Hamburg, and Copenhagen, is steadily declining, and this result Prof. Metchnikoff ascribes to unconscious inoculation by infection with mild or benign strains of the tubercle bacillus, which serves to protect against the virulent organism. It is on these lines that Prof. Metchnikoff believes that the stamping out of tuberculosis is to be attempted, viz., the discovery or artificial production of strains of the tubercle bacillus having but slight virulence, which, on inoculation in suitable doses, will serve to protect the inoculated against the virulent organism.

R. T. H.

REPORT OF THE GOVERNMENT CHEMIST.

IN his report[1] upon the work of the Government Laboratory for the year 1911–12, the Government Chemist gives a short historical introduction, showing the principal steps in the progress of the department.

The origin of the laboratory dates back to 1843. Its duties at first were mainly concerned with checking the adulteration of tobacco; but subsequently its scope was extended, and other branches of the executive besides the fiscal departments obtained permission of the Treasury to avail themselves of its services. Recently, in order to promote the centralisation of Government chemical work, and to place all the departments using the laboratory on the same footing, it was constituted a separate establishment, with the official title of "The Department of the Government Chemist." There are two branches of the laboratory, namely, the main building, at Clement's Inn Passage, and a smaller establishment at the Custom House.

In the present report the matter has been classified more conveniently than formerly, and in respect of the chief substances examined explanatory notes are given, showing for what purposes the analyses are undertaken. These modifications make the report so much the more easily understood by the non-technical reader.

Evidence of the necessity for the kind of analytical control which the laboratory exercises is to be found in plenty in the pages of the report. For example, in the matter of safeguarding the revenue it was found that the "declarations" of brewers, on which the assessment of beer-duty is based, were erroneous in 20 per cent. of the cases examined during the year. Also, out of 2608 samples of certain exported spirituous articles on which rebate was claimed, the proportion of alcohol was found to have been wrongly stated by the exporters in 315 instances, and the amount of sugar in 185.

In connection with the supervision of foodstuffs, more than a quarter of a million pounds' weight of tea was condemned as containing sand or being otherwise unfit for consumption. This quantity of tea, it is noted, though apparently large, is small compared with the total amount of tea imported, namely 347 millions of pounds. The rejected tea was allowed to be used free of duty as a source of the alkaloid caffeine. Of the samples of imported butter examined, 30 per cent. were found to contain boron preservative, and 13·7 per cent. to have been coloured artificially. Oysters suspected to have caused copper poisoning were proved, on analysis, to contain not only copper, but zinc. A few samples of malt and beer were found to contain an excessive quantity of arsenic, which was generally traced to the fuel used in drying the malt.

For many years past analytical work has been done in connection with supervision of dangerous trades by the Home Office. Numerous samples of air from collieries were examined last year for the purposes of the Mines Regulation Bill; and from pottery works where cases of lead poisoning had occurred fifty-six specimens of the glazes in use were taken; these proved to contain lead ranging in amount from 9 to 51 per cent. With few exceptions the whole of the lead present was "soluble" lead—accentuating once more the danger which attends the use of this form of lead in pottery glaze.

The total number of analyses and examinations made during the year was 195,170, as compared with 186,044 for the preceding year.

[1] Report of the Government Chemist upon the Work of the Government Laboratory.—Cd. 6363.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held, as usual, on St. Andrew's Day, November 30, when the report of the council was presented, the president's address was read, and the new council, the names of the members of which were given in NATURE of November 14 (p. 312) was elected.

From the report of the council, we learn that the Government of India has agreed to appoint an additional European assistant in the Indian Meteorological Department, and to maintain the scheme of observations of the upper air for a further period of ten years, unless in the meantime they prove void of result.

The council of the Royal Cornwall Polytechnic Society has informed the Gassiot Committee that it will be necessary, owing to insufficiency of funds, to discontinue Falmouth Observatory at the end of the year. Individual members of the committee have been giving their support to efforts that are being made to secure the necessary financial assistance for that observatory from Government.

The attention of the council has been directed to the urgent desirability of installing self-recording magnetic instruments at suitable stations in South Africa, as few standard records of terrestrial magnetism are available for the southern hemisphere; and also to the great need of providing stations to take part in the observations of tidal disturbance of the solid earth, which are now being inaugurated in Europe and America under the general direction of Dr. Hecker, of Strasburg. The council has transmitted to the Royal Society of South Africa, for its information and for transmission to the South African Government, the opinion of the Royal Society that provision for installing and attending to permanent magnetographs, giving continuous magnetic records at suitable observatories at different places in South Africa, and also arrangements for observations on tidal deformation of the solid earth, are urgently needed in the international interests of the sciences of terrestrial magnetism and geodesy.

Reference was made by the council last year to the provision of new buildings for the National Physical Laboratory. The estimated cost of these buildings, together with the Wernher Metallurgy building recently erected, was 30,000*l.*, or 35,000*l.* including equipment. Towards this total the sum of 10,000*l.* was given by Sir Julius Wernher, and 15,000*l.* will be provided by the Treasury. Some additional amounts have also been received. For the further sums necessary the laboratory will be dependent on the assistance of other donors. A committee, with Sir William White as chairman, consisting of representatives of the various societies and institutions connected with the laboratory, has been appointed to raise the necessary funds, some 9000*l.* in all, and help has already been received from some of the City companies and others.

In his address, the president, Sir Archibald Geikie, K.C.B., referred first to the losses the society had sustained by death since the previous anniversary meeting. Four foreign members have passed away, and ten Fellows, among whom were two former presidents of the society and Copley medallists. We print from the address the descriptions of the prominent points of the work of the medallists of this year.

The Copley Medal.

The Copley medal is this year assigned to Prof. Felix Klein, of Göttingen, for his researches in mathematics. Prof. Klein is, perhaps, most widely known in this country for his investigations in geometry, which attached themselves closely to the work of Cayley and other British mathematicians. This work has expanded and systematised our conceptions of non-Euclidean geometry, and indeed the philosophy of geometry in general. Of at least equal importance have been his researches in theory of functions. In his earlier papers he dealt mainly with the transformation of elliptic functions and the related theory of modular functions. The key to the most of what followed lies in the memoir, "Neue Beiträge zur Riemannischen Functionentheorie," published in 1882. In this memoir, quite independently of Poincaré, and from an entirely different point of view, Klein lays the foundations of the theory of automorphic functions.

The Rumford Medal.

This year the Rumford medal has been awarded to Dr. Heike Kamerlingh Onnes, of Leyden, in recognition of the great value of his contributions to low-temperature research, among which his liquefaction of helium is the most noted. He has founded at Leyden the most thoroughly equipped laboratory in the world for investigations in low temperatures. In that institution a series of researches has been carried out regarding the effects of such great cold as can be obtained by the use of liquid hydrogen and even helium on the properties of substances, such as their magnetic relations and the electrical resistance of pure metals and alloys, the results of which are most striking and important for future progress.

The Royal Medals.

The awards of the two Royal medals annually given by our patron the King have received his Majesty's approval. One of these medals has been assigned to our colleague, Prof. William Mitchinson Hicks, as a mark of the society's appreciation of the value of his contributions to physical science. Among his researches may be specially mentioned those on hydrodynamics, and particularly on vortex motion, published in the Philosophical Transactions. Of late years he has devoted much attention to the numerical relations which exist between the frequencies of lines belonging to the same spectral series.

The other Royal medal has been adjudged to Prof. Grafton Elliot Smith, in recognition of the value of his biological investigations, more especially in regard to the morphology of the brain as developed in amphibians, reptiles, birds, monotremata, marsupials, and nearly every group of placental mammals. Prof. Elliot Smith's work among the ancient cemeteries of Nubia may also be mentioned. Already it has brought to light many interesting anatomical features in the buried remains of the former population of the Nile Valley.

The Davy Medal.

The Davy medal has been assigned to Prof. Otto Wallach for his researches in organic chemistry, particularly in regard to the essential oils. Our present knowledge of these complex vegetable products is largely the result of the numerous analytical investigations which he has carried out in the laboratories of Göttingen. He has made many important discoveries, more especially in connection with the cyclo-olefines and their derivatives, and his researches on these compounds have played a notable part in the general development of organic chemistry.

The Darwin Medal.

The Darwin medal is this year awarded to one of the sons of the illustrious man in whose honour this medal was founded twenty-two years ago. Mr. Francis Darwin by his researches has done much to emphasise the importance of plant movements in relation to environment, and has shown how strong is the evidence for the view that these various movements are the expression of the plant's own individuality in response to external stimuli, and that they have been developed or acquired by the plant as an adaptation to environment in the struggle for life. It is pleasant to remember that these interesting researches have been a continuation of the work which he carried on, conjointly with his father, in the long series of observations and experiments which are recorded in that important treatise, "The Power of Movement in Plants."

The Buchanan Medal.

This medal is awarded every five years in recognition of distinguished services to hygienic science or practice in the direction either of original research or of professional, administrative, or constructive work, without limit of nationality or sex. It has this year been adjudged to Colonel William Crawford Gorgas, for his remarkable services under the American Government, in combating the terrible scourge of yellow fever. As chief sanitary officer at Havana, Cuba, he there for the first time applied those sanitary methods by which the yellow fever was almost entirely eradicated from the place. This marked success led to his being entrusted in 1904 with a similar but greater task in the Panama Canal zone, where the same disease was rampant, and where he is still engaged. His success in that region has been not less conspicuous.

The Hughes Medal.

This medal has been adjudged to William Duddell, F.R.S., in recognition of the value of his researches in technical electricity, and, in particular, his investigations with the oscillograph on telephonic sounds, his work on radiotelegraphy with the thermo-galvanometer, his development of the vibration galvanometer, and his investigations on the production of currents of very high frequency by the electric arc and by mechanical means.

At the anniversary dinner, held on Saturday evening, the new German Ambassador (Prince Lichnowsky) and Prof. Metchnikoff were among the guests. In proposing the toast of "The Royal Society," Sir Rickman Godlee, president of the Royal College of Surgeons, dwelt upon the relations of the society to medicine. After responding to the toast, Sir Archibald Geikie proposed the health of the German Ambassador, and pointed out that this was the first public dinner that their guest had attended since he arrived a few weeks ago.

In the course of his reply, Prince Lichnowsky remarked:—

"Of all bonds that unite nations none are stronger than intellectual sympathy, and nothing is more apt to promote a real and lasting understanding between nations than the common struggle against darkness, ignorance, and misery. From time immemorial a close connection has existed between the intellectual leaders of our two great countries. Newton laid the basis of the modern development of physical science in Germany. Carlyle's work on Frederick the Great is a standard work, unrivalled, and of the works of all foreign historians the most popular in Germany. Hume was the predecessor of Kant and Schopenhauer, and I do not believe that in any country in the world are Shakespeare and Byron more fully appreciated or deeply understood than in Germany. I am confident that this close intellectual connection will in the future as in the past be a powerful help to the efforts of all those who work for the establishment of good understanding and harmony between our two kindred peoples."

Prof. Metchnikoff replied to the toast of "The Guests," in a speech in which he referred, in appreciative terms, to the influence the society exerted upon scientific progress, and the recognition it gave to the merits of men of science in many parts of the world. He cited particularly the case of Mendeléeff, who, though refused admission to the St. Petersburg Academy of Science, was elected a foreign member of the Royal Society.

NOTES.

In reply to a question asked in the House of Commons on Monday, the Prime Minister stated that he feared the Government will not be able to find time to pass the Mental Deficiency Bill this session, but that the Home Secretary hopes to reintroduce the Bill early next session embodying the amendments made by the Standing Committee. The pledge that the Bill would be passed this session is thus held to be of no account. That Parliamentary exigencies should cause the jettisoning of the Bill is greatly to be deplored. Men of science know with a certainty that arises out of their qualifications that the problem of the feeble-minded and mentally deficient does not stand still. Its urgency caused the appointment of the Royal Commission in 1904; the report emphasised the necessity for immediate action in 1908; yet December of 1912 finds the subject shelved and put on one side. *The Times* has opened its columns to various expressions of feeling on this occasion, but many people who do not see its files will share in Sir Edward Fry's "distress and dismay" at a postponement which is "little short of a national calamity," and agree with the long list of distinguished signatories in the issue of November 28, that "this neglect is causing untold suffering to thousands of feeble-minded individuals who, because it is impossible under the existing law to train them and care for them, become inebriates, prostitutes, criminals, and paupers." Nor is it only these persons themselves with whom we need concern ourselves. They leave behind them a new generation of mentally and physically degenerate children, increasing daily in number, to be a shame to our national life, and a menace to our racial superiority.

THE High Commissioner for the Commonwealth of Australia has received official information of the arrangements that are being made for the visit of the British Association to Australia in 1914. A Federal Council has been formed, under the patronage of the Governor-General, with the Prime Minister as chairman. The members of the association will arrive at Fremantle on August 4, Adelaide August 8, Melbourne August 13, Sydney August 20, and Brisbane August 27, and those returning home by the shortest route will reach London on October 11. The Commonwealth has granted 15,000*l*. to be handed to the British Association by the High Commissioner to cover the passages of not fewer than 150 official representatives, including selected Dominion and foreign men of science. A special invitation has been issued to Sir Charles Lucas, formerly head of the Dominions Department of the Colonial Office. Dr. Rivett has been appointed organising secretary, and will visit London next year. The Governments of the several States offer special facilities for prolonged visits of men of science interested in special problems in Australia.

A VERY interesting tract of wild country has just been vested as a nature reservation in the National Trust for Places of Historic Interest or Natural Beauty. This is Blakeney Point, in Norfolk, a tract of about 1000 acres, consisting of three and a half miles of the shingle spit, with the sand-dunes and salt-marshes protected by it; the frontage on the North Sea is three and a half miles, viz. the end of the spit. A remarkable feature of the tract is the series of terrains instituted by the silting process, and the resulting formation of series of vegetations. Norfolk generally is one of our richest counties in rare flora and fauna. Blakeney Point is a typical area of the county in this regard. It possesses the four chief species of Statice (sea lavender), the very rare *Mertensia maritima* (oyster plant), and the fine shrub, sea-blite, *Suaeda fruticosa*, which grows in great profusion. It is famous for its birds, protected for some years now by the Wild Birds' Protection Society. The oyster-catcher, ringed plover, common and lesser tern breed freely; the latter and various gulls are extraordinarily abundant. Being a sort of "hook" in the North Sea, the point receives interesting stragglers, seals, sharks, and last year a whale. Salt-marshes such as these are rich in insect fauna. The gift is due to the generosity of the Fishmongers' Company, and some private individuals. *The Times,* from whose report we quote, well says "it is hoped that with Blakeney Point a satisfactory beginning of the establishment of 'national reserves' may be made in England."

THE death is announced, in his seventy-ninth year, of Sir Charles Whitehead, an authority in agricultural matters. He was an active member of the council of the Royal Agricultural Society from 1870 to 1898, was chairman of the botanical and zoological committee of the society, and wrote much in its Journal. He was a vice-president of the society from 1885–1907. From 1893 to 1897 Sir Charles Whitehead served on the Royal Commission on Agriculture, and from 1884 to 1887 he advised the Agricultural Department of the Privy Council Office, when he was appointed agricultural adviser—the first in this country. He was afterwards transferred to the Board of Agriculture as technical adviser. Among his numerous contributions to the literature of agricultural science may be mentioned "The Agriculture of Kent," his leaflets on insects and fungi, and his reports on the Hessian fly, the means of checking potato disease, and on the attack of the diamond black moth. He was a fellow of the Linnean, Royal Geographical, and Geological Societies.

THE death is announced, at the age of ninety years, of Dr. Robert Fletcher, the medical bibliographer. Dr. Fletcher was born at Bristol, and qualified as a member of the Royal College of Surgeons in 1844. Later he took the degree of M.D. at Columbia University. He inaugurated the Army Medical Library at Washington, U.S.A., and, in association with Dr. J. S. Billings, the present head of the New York Public Library, he compiled and edited the index catalogue of the library of the Surgeon-General's Office, Washington, and was entirely responsible for some of the volumes. With Dr. Billings, too, he compiled the "Index Medicus," which was later revived and taken over by the Carnegie Institution, when it was edited by Dr. Fletcher. Since 1880, thirty-two folio volumes of the index have been issued. Dr. Fletcher wrote also papers on anthropology and folklore. He formerly lectured on medical jurisprudence at one of the Washington schools, and afterwards gave an annual course of lectures on the subject at the Johns Hopkins Hospital School at Baltimore. The council of the Royal College of Surgeons of England in 1910 conferred upon Dr. Fletcher the honorary medal of the college for "distinguished labours eminently conducive to the improvement of natural knowledge and the healing art."

MR. T. FRANCIS CONNOLLY, of the Solar Physics Observatory, South Kensington, has been appointed an assistant-inspector of scientific supplies at the India Stores Department, Lambeth.

THE Physical Society's eighth annual exhibition, to be held on Tuesday, December 17, at the Imperial College of Science, South Kensington, will be open in both the afternoon (from 3 to 6 p.m.) and in the evening (from 7 to 10 p.m.). Mr. S. G. Brown will give a discourse at 4.30 and again at 8 p.m., on some methods of magnifying feeble signalling currents. About thirty firms will exhibit instruments and other apparatus.

REMAINS of a human skull and mandible, considered to belong to the early Pleistocene period, have been discovered by Mr. Charles Dawson in a gravel-deposit in the basin of the river Ouse, north of Lewes, Sussex. Much interest has been aroused in the specimen owing to the exactitude with which its geological age is said to have been fixed, and it will form the subject of a paper by Mr. Dawson and Dr. Smith Woodward to be read before the Geological Society on December 18.

A COURSE of twelve Swiney lectures on geology in connection with the British Museum (Natural History) will be delivered by Dr. T. J. Jehu, in the Lecture Theatre of the Victoria and Albert Museum, South Kensington, on Mondays, Thursdays, and Saturdays, at 3 p.m., from Saturday, December 7, to Saturday, December 21 (inclusive), and from Saturday, January 4, to Monday, January 13 (inclusive). The subject of the course is "The Record of Life as revealed in the Rocks." Admission to the lectures is free.

ON Friday last, November 29, Mr. Edgar A. Smith, assistant-keeper in the zoological department of the Natural History Museum, was, in view of his approaching retirement, presented by the director, Dr. L. Fletcher, F.R.S., on behalf of the subscribers, including many of his colleagues and other friends, with a tea and coffee service, a drawing-room clock, and a pair of field-glasses. Mr. Smith joined the staff of the museum in 1867, and has served the trustees for the exceptional length of time of forty-five years; at their special request he has consented to continue his duties up to the end of March next.

WE are informed that the "Cecil" medal and prize of the Dorset Field Club for 1912–13 will be awarded for the best paper on the known sources of supply of petroleum oil and its various products; its advantages or disadvantages compared with the future price, illuminating power, heat and energy of coal by land, sea, and air. The competition is open to any person who was between the ages of eighteen and thirty-five on May 9, 1912, and either was born in Dorset or had on May 9, 1912, resided in the county for the previous twelve months. Further particulars may be obtained from Mr. H. Pouncy, *Dorset County Chronicle* Office, Dorchester.

As a result of a suggestion contained in a paper on the nomenclature of alloys, read by Dr. W. Rosenhain before the Institute of Metals in January last, a committee consisting of representatives of the Institute of Metals and Allied Societies has been appointed under the name of the Nomenclature Committee, and will shortly hold its first meeting. Another new committee has been appointed by the council for the purpose of assisting the Dominions Royal Commission in the inquiry into the question of the supply of non-ferrous metals and ores in this country. A report dealing with this subject is being prepared by the committee, of which Prof. T. Turner is the honorary secretary.

The following are among the lecture arrangements at the Royal Institution, before Easter:—Sir James Dewar, a course of six experimentally illustrated lectures, adapted to a juvenile auditory, on Christmas lecture epilogues: December 28, alchemy; December 31, atoms; January 2, light; January 4, clouds; January 7, meteorites; January 9, frozen worlds; Prof. W. Bateson, six lectures on the heredity of sex and some cognate problems. Prof. H. H. Turner, three lectures on the movements of the stars: the nebular hypothesis; the stars and their movements; our greater system. Mr. Seton Gordon, two lectures on birds of the hill country. Prof. B. Hopkinson, two lectures on recent research on the gas engine. Mr. W. B. Hardy, two lectures on surface energy. Sir J. J. Thomson, six lectures on the properties and constitution of the atom. The Friday evening meetings will commence on January 17, when Sir J. J. Thomson will deliver a discourse on further applications of the method of positive rays. Succeeding discourses will probably be given by Prof. J. O. Arnold, Mr. G. M. Trevelyan, Sir John Murray, Prof. A. Gray, Mr. S. U. Pickering, Mr. C. T. R. Wilson, the Hon. R. J. Strutt, Dr. A. E. H. Tutton, and other gentlemen.

The influence of Libyan migrations on the people of the Nilotic delta and the southern shores of the Ægean is now generally admitted. A useful collection of facts illustrating the historical aspects of the question from Egyptian and other sources is made in an article by Mr. Oric Bates under the title of "History of the Eastern Libyans," contributed to *The Cairo Scientific Journal* for August last. He emphasises the constant protest by these people against foreign dominion, and their failure to amalgamate with their European invaders. With the Carthaginians they certainly mixed to some extent; but there was no conspicuous intermixture until Arab times, when there arose the great Berber-Arab dynasties of the Atlas, and eventually the Negro-Berber-Arab Songhay empire in the south-west. Fierce, predatory, and impatient of foreign dominion, yet incapable of ruling themselves, they were a race without a mission until they became sufficiently united with the Arabs under Islam to give strength and weight to the Mohammadan dynasties of Africa and Spain.

The archæological department of the Geological Survey of Canada has begun a systematic study of the archæology of the whole of the Dominion. Messrs. Harlan I. Smith and W. J. Wintemberg conducted reconnaissances in the Ottawa Valley, Nation Valley, and neighbouring regions. Cave dwellings were found in the Laurentian Mountains near the north side of the Ottawa River containing pottery of an Iroquoian type, and also village sites probably of Algonkin origin; they are all small, and are generally near the streams on camping-places suitable for canoe-parties. They also explored some large Iroquoian village sites near the headwaters of the Nation, which are usually on the top of low hills near a spring or small stream, and thus differ from those previously mentioned. Charred corn (maize) and beans are found; thus the people were agricultural. Stone arrow-points are exceedingly rare, and those made of antler are uncommon. The grooved axe has not been found; even celts are rare, but fragments of pottery and bone awls are common. A number of burials, usually unaccompanied by artifacts, have been found; the skeletons show that the people suffered from bone diseases, and that there was a considerable infant mortality. They were apparently all of one physical type. Messrs. G. E. Laidlaw and W. B. Hicker have also done useful archæological work, as have two volunteers, Dr. T. W. Beeman and Mr. C. C. Inderwick. On a previous occasion we directed attention to the advantage that would be gained by Canadian archæology by the appointment of Mr. Smith as government archæologist, and now we congratulate him on having secured so many zealous co-workers.

Among many articles of special interest in the Christmas issue of *Chambers's Journal* is one by Mr. Waldemar Kaempffert on "Eugenics and What it Means." Some striking instances are given of the way in which the mental and physical characters of a human being are reproduced again and again in his descendants. Particulars of 1200 descendants of Max Jukes, a criminal fisherman born in 1720, are compared with statistics of the 1394 descendants of Jonathan Edwards, the distinguished American. The facts obtained by Prof. Karl Pearson and other workers show the vital importance of dealing promptly with the question of the mentally defective. It is urged that the manner in which family traits, good and bad, are inherited should be studied, and that "we must prevent the perpetuation and increase of a stock which we know is a menace to the nation."

Lemurs and their relatives form the subject of a popular article by Miss S. S. Müller in *The Museum News* of Brooklyn. The author appears to be unaware that pottos (Perodicticus) occur in Uganda, as well as in West Africa.

In the November number of *The Annals and Magazine of Natural History* Dr. Ridewood states that certain specimens in the Natural History Museum collected in the Antarctic during the voyage of the *Erebus* and *Terror* in 1841 or 1842 are apparently referable to the genus Cephalodiscus (an organism on the border line between vertebrates and invertebrates), which was named in 1876 on the evidence of examples brought home by the *Challenger*. They seem referable to *C. nigrescens*, described by Sir Ray Lankester in 1905.

No fewer than five different authors, Messrs. Griffini, Heller, Hilzheimer, Lotichius, and Schwarz have recently published independent communications on the members of the quagga and zebra group, and it is not a little remarkable how their conclusions differ. Mr. Schwarz (*Arch. Naturges.*, vol. lxxviii., Heft 7, p. 34) considers that *Equus quagga* should include the *burchelli* group, and also that certain races of the former, such as *E. greyi*, which have been described from the Cape, are invalid, while it is also considered that *E. grevyi* is not generically separable from the other. The latter is, however, referred to a new genus by Dr. Hilzheimer (*Abh. Senckenberg Ges.*, vol. xxxi., p. 85, under the preoccupied name Megacephalon, while the *E. burchelli* group is kept distinct from *E. quagga*. Mr. Heller (Smithson. Misc. Collect., vol lx., No. 8, p. 1) also generically separates Grévy's zebra, as Dolichohippus. Mr. Griffini's work was reviewed in NATURE of November 28 (p. 358); the remaining publication does not demand further notice.

AN interesting research on the sensory perceptions of the fowl tick (*Argas persicus*) has been carried on in the Quick Laboratory, Cambridge, by Dr. E. Hindle and Mr. G. Merriman, who publish their results in *Parasitology*, vol. v., No. 3, 1912. The reaction of the ticks, in all stages, to light is negative; they are also sensitive to pronounced differences in the intensity of illumination, selecting the darker places to rest in. Occasionally this "negative phototropism" is masked, because the ticks are decidedly attracted to a source of heat. They bring as much as possible of the surface of their bodies into contact with surrounding objects. Experiments with vapours showed that the sense of smell is very well developed, and observations on ticks that had suffered amputation of the terminal segments of their front legs proved that the chitinous sac, there situated, and known as "Haller's organ," is olfactory in function. The impressions received through this organ, together with the positive reactions to heat and contact, are believed to be of service to the ticks in enabling them to find appropriate hosts.

WE have received a report of the Amphipoda of the Scottish Antarctic expedition (Trans. Roy. Soc. Edinburgh, xlviii. (1912), pp. 455–520, two plates), by Prof. Charles Chilton, of Canterbury College, New Zealand. The collection contained fifty-six species from Antarctic or sub-Antarctic seas. The great majority of these were already known, but nine new forms are established. It appears that many species range around the globe in sub-Antarctic seas, and the author also directs attention to the similarity or identity of some Arctic and Antarctic species. What interpretation is to be put on this "bipolarity"? Prof. Chilton points out that a species which occurs both in the Arctic and the Antarctic is not always entirely absent from the tropics, but exists there in deeper waters. Moreover, the tropical or temperate form is sometimes so much smaller than the polar one that it has been reckoned as a separate species. For it must be noted that, for some reasons not altogether understood, many Amphipods find their optimum environment near the Arctic and Antarctic regions, not only occurring there in greatest abundance, but attaining a size far larger than that usual for similar or identical species in warmer seas.

A USEFUL list of British lichens, published by Messrs. Dulau, at 1s. net (post free 1s. 1d.), has been compiled by the secretary of the Lichen Exchange Club, and contains the names of more than 1200 species, belonging to 142 genera. This list will be of service to collectors, but the club intends shortly to publish a census catalogue and also "An Easy Account of British Lichens," of which the latter will doubtless be of greater utility to general students. The enterprise of the Lichen Exchange Club is greatly to be commended, as it is likely to lend an impetus to the study of this difficult group of plants among field botanists, and the issue of these handy and inexpensive compilations is well-timed, following as they do the recently completed monograph of the lichens in the British Museum herbarium.

THE synoptic weather maps of the North Atlantic and adjacent continents during the interval of November 4–14, shown on the first issue of the meteorological chart for December by the Meteorological Office, are of more than usual interest. During the first few days atmospheric disturbances occupied the region from Greenland to the Azores and Canary Islands, but subsequently the maps show that a remarkable development of high pressure took place, and "a vast anticyclone ruled from the United States across the Atlantic and Europe to the greater part of Siberia," and much fine weather was experienced. The barometric pressure over central Siberia exceeded $31\frac{1}{4}$ in. on two days, and was down to $28\frac{3}{4}$ in. near Iceland. In the week commencing with November 10 a more wintry type of weather set in, with a large anticyclone central about 52° N., 22° W., and depressions on the Newfoundland side.

A USEFUL paper, entitled "Data of Heavy Rainfall over Short Periods in India," has recently appeared in the Memoirs of the Indian Meteorological Department (vol. xxi., part iii.). The information is arranged in chronological order showing (1) daily falls exceeding 10 in. in each of the fourteen chief political divisions for the period 1891–1911, and also the amounts recorded on the preceding and following days, with a supplementary table giving from fragmentary sources records of heavy rainfall prior to 1891; (2) bursts of heavy rain lasting a few hours. No general summary is given of the maximum daily falls, but the figures are astounding; records of 20 in. and upwards are not uncommon, with considerable falls on the previous and following days. At Cherrapunji (Assam) 40·8 in., in the United Provinces 35 in., and in the Punjab 32·4 in. are quoted within twenty-four hours. This valuable information has been published to meet demands for trustworthy data for use in irrigational and commercial undertakings.

THE American journal *Good Lighting* publishes in its October number a well-illustrated article, by Messrs. C. L. Law and A. L. Powell, on small store lighting in that country, a subject on which the authors read a paper at the Niagara Falls meeting of the Illuminating Engineering Society in September. More than 800 small stores in the less prominent streets of New York and neighbouring cities were investigated, and the authors embody their results in a table showing the maximum, minimum, and average watts per square foot of floor area, based on the use of tungsten filament lamps with glass reflectors. They conclude by recommending a definite number of watts per square foot for each type of store. Although the internal arrangements of an American store differ considerably from those of an English shop, the recommendations are of importance to English illuminating engineers, and we reproduce them:—Art store, 1·3; bakery, 0·8; barber, 1·2; cigar, 1·4; clothing 1·5; confectionery, 1·0; delicatessen, 1·1; drug, 1·2; dry goods, 1·0; florist 1·1; grocery, 1·0; haberdashery, 1·7; jewellery, 1·6; meat, 0·9; millinery, 1·3; music, 1·1; restaurant, 1·1; shoe, 1·0; stationery, 1·0; wine 1·0 watt per square foot of floor.

THE October issue of *Science Progress* contains a full account, by Mr. W. A. Davis, of the experiments on the chemical effects of light, to which so much attention has been directed in recent years. The changes produced may be of some half-dozen types. The most important of these is probably a reciprocal oxidation and reduction, but isomeric and polymeric change, synthesis and hydrolysis are also effected in many cases. These changes are somewhat irregular in their occurrence; thus the nitrobenzaldoximes undergo isomeric change on exposure to light, whilst the parent substance remains stable; again, maleic acid is converted into fumaric acid by light in presence of bromine, but the other halogens do not produce this effect. One of the most striking changes is that of *allo*-cinnamylidene acetic acid,

$$C_6H_5.CH : CH.CH : CH.CO_2H,$$

which, when dissolved in benzene with 3 per cent. of its weight of iodine, actually sets within three minutes on exposure to light, owing to the conversion of 80 per cent. of the acid into a less soluble isomeride; in the dark no change occurs in six days.

WE have received from the Carnegie Institution of Washington a monograph on the conductivity, &c., of aqueous solutions of salts and organic acids, by Prof. H. C. Jones. As this summarises the data that have been pulished in a series of American papers, it will be of considerable value to those who have to refer to the figures now collected. In the original papers the data for the range 0° to 35° C. were all issued separately from those from 35° to 65° C.; in such cases the advantages of publishing in bulk rather than in successive portions cannot be emphasised too strongly. The present publication is therefore doubly welcome.

MESSRS. T. C. AND E. C. JACK have added another dozen volumes to their "People's Books," which are published in cloth binding at 6*d*. net. The additions include a volume by Dr. T. G. Bonney, F.R.S., entitled "The Structure of the Earth," in which he gives a very brief statement of the problems and methods of geology, and a popular account of the disintegrating forces at work modifying the earth's crust, of volcanoes, land movements, and the life-history of the earth. In "Hypnotism and Self-Education," Dr. A. M. Hutchison writes on the present-day position of medicine as regards diseases which demand healing other than that which can be given by drugs. A volume by Mr. William Hall, R.N., on "Navigation," is intended to initiate the reader "as a sort of honorary member in the great company of seafarers," and expounds simply such subjects as dead reckoning and astronomical navigation. Mr. R. G. K. Lempfert, superintendent of the Forecast Division of the Meteorological Office, describes in his volume "Weather Science" how meteorological observations are made and their relation to the changes going on in the atmosphere, and explains what can be learnt by combining the results of observations taken at a number of stations. Two other of the books—"Marriage and Motherhood," by Mr. H. S. Davidson, and "The Baby: A Mother's Book," by a Mother, provide in simple words the information with which every wife and mother should be familiar.

IN view of the increasing importance of the study of public hygiene, the syndics of the Cambridge University Press have decided to publish a series of volumes dealing with the various subjects connected with public health. The provisional lists of subjects, all of which will be treated by experts, include:—The causation of tuberculosis, house-flies and disease, bacteriology of foods, tropical hygiene, sewage disposal, water purification, school hygiene, sound and unsound foods, domestic sanitation, chemical analyses of foods, &c. It is intended that the whole series shall appeal not only to medical men but also to those engaged in the study or administration of public health at home or abroad. The series will be under the general editorship of Dr. G. S. Graham-Smith and Mr. J. E. Purvis.

MESSRS. KEGAN PAUL, TRENCH, TRÜBNER AND CO., LTD., are about to publish a work on the "Theory of Evolution," by the Rev. K. Frank, S.J., with a chapter on ant guests and termite guests, from the pen of Father E. Wasmann, S.J. The work has been translated from the German by Mr. C. T. Druery, and will be illustrated.

OUR ASTRONOMICAL COLUMN.

RADIUM IN THE CHROMOSPHERE.—In No. 454 of *The Observatory*, Dr. Dyson replies to the views expressed by Mr. Evershed and Mr. Mitchell concerning his suggestion that there is some evidence for the existence of radium among the elements spectroscopically disclosed in the solar chromosphere.

His contention is that the chromospheric spectrum is an enhanced-line spectrum, and that before accepting any coincidence of Fraunhoferic and chromospheric lines as evidence of identity of source, the behaviour of any line in question in the spark should be taken into account. On these grounds he questions Mr. Mitchell's identifications of the lines λ4699·52 and λ4533·34 with lines given by Rowland. Other cases are against the radium identifications, however, and Dr. Dyson expresses the hope that the question will receive attention at future eclipses, and that the radium line at λ5813·9, referred to by Mr. Evershed, will be looked for.

OBSERVATIONS OF JUPITER.—Despite the unfavourable conditions of altitude and weather some interesting observations of Jupiter were made during May-July at the observatory of the French Astronomical Society, and the results, with drawings, are now published in the November number of *L'Astronomie*.

The north polar region was much darker than the neighbouring region during May, but later it cleared until its hue was similar to the north temperate zone. Great changes of form and relative movement were observed in the great southern perturbation, and about the middle of July the displacement was at the rate of about 1000 kms. per day; these changes are illustrated by curves and drawings. Later observations, September 13 and October 9–10, showed that the north equatorial band, so inconspicuous for the past four years, had suddenly become one of the darkest and most conspicuous details on the planet, and it suggested that, at the next opposition, the aspect of Jupiter may be found to be considerably transformed.

THE DISCOVERY OF GALE'S COMET, 1912*a*.—In No. 1, vol. xxiii., of the Journal of the British Astronomical Association Mr. Gale, of Waratah (N.S.W.), tells the story of the discovery of his second comet, 1912*a*. Having to travel considerably, he finds but little time for telescopic work, but carries with him a field-glass of 2-in. aperture and a $\times 3$ magnification. Examining the northern part of Centaurus on September 8, he saw a strange object of obviously cometary character, and on the next evening, having arrived at Mr. Beattie's observatory at Sydney, he was able to confirm the discovery and get a position. At the time of discovery the comet's magnitude was about 6, and the discovery emphasises the fact that a keen observer under a clear sky may do important work without possessing any considerable instrumental equipment.

A STAR CALENDAR.—We have received a copy of the "Star Calendar," by Mrs. H. Periam Hawkins, for 1913, and can strongly recommend it to all amateur astronomers. With its revolving disc it enables one to find the position in the sky of any constellation, or the time of rising and setting in these latitudes, for any hour in the year; the price is 1*s*. net. Mrs. Hawkins has also prepared, as in previous years, a "Star Almanac," which contains a great deal of useful information frequently needed. In addition to star charts for the four seasons, various useful tables and notes, the almanac contains a reproduction of Dr. Wolf's photograph of the "Butterfly" nebula of the Pleiades, and quotes Sir Norman Lockyer on the employment of the stars as guides to travellers; the price is 6*d*. net, and both calendar and almanac are published by Messrs. Simpkin, Marshall, Hamilton, Kent and Co.

THE SPECTROSCOPIC BINARY β SCORPIONIS.—In 1908 Dr. Slipher found that the calcium lines in the spectrum of β Scorpionis did not appear to partake of the oscillations of velocity shown by the other lines, and, also, that they were sharply defined instead of being broad and diffuse, as are the other lines.

The inquiry as to this peculiar behaviour has been taken a step further by Mr. J. C. Duncan, who, in No. 54 of the Lowell Observatory Bulletins, discusses a large number of new measures of the spectrum carried out by him. The elements which best represent the orbit give a period of 6·8284 days, an eccentricity of 0·27, and a projected semi-major axis of 10,990,000 km. for the brighter, and 14,450,000 for the fainter, component; the semi-amplitude of the velocity curve for the brighter star of the system is 126 km. per sec., and for the fainter star 166 km. per sec.

While the velocity of the centre of mass of the system is $-8·0$ km. per sec., that given by the calcium radiation, K, is 16·6 km. per sec., thus showing a difference of more than 8 km. per sec., which seems too great to be attributed to errors of measurement. This seems to support Hartmann's suggested explanation for a similar phenomenon in the case of δ Orionis, viz. that the calcium absorption is produced by a mass of calcium vapour, independent of the star, moving with a constant velocity between the earth and the star. Observations of other stars in the Scorpio, Orion, and Perseus regions, made by Dr. Slipher, suggest the presence of such calcium clouds in all those regions. On the other hand, a suspected shortening of the period of β Scorpionis would suggest that the calcium cloud envelops the binary system, and produces the effect of a resisting medium on the revolution of the components, but the suspicion needs much more confirmation than is at present forthcoming.

MEDICAL RESEARCH AND PUBLIC HEALTH.

ON November 28, at a meeting of the General Medical Council, Sir Clifford Allbutt raised the question, how the grant for research provided by the National Insurance Act could be used to the best advantage. He looked forward, not to a crusade against tuberculosis alone, but to a crusade against many other endemic diseases, a "general movement all along the line against all these plagues." He pointed out, very truly, that research, diagnosis, and treatment go hand in hand; that the business of pathological and clinical laboratories, in great cities, is to be in touch with men in practice, and to educate them in the methods of science, and in the results of science. He was opposed to the founding of one large institute in London: he was afraid that it would "harden into a bureau"; he desired to see more use made of the many institutions already founded in diverse parts of the country, in our great cities, and in our university cities. Medical research and medical education are inseparable; the doctor must not regard bacteriological institutes as places where he can put a specimen in the slot and get a diagnosis; he must take an intelligent part in the work of the institute. This view was approved by the General Medical Council.

On November 30, at a meeting of the Metropolitan Asylums Board, a recommendation was made by the Hospitals Committee, "that in view of the continued incidence and fatality of zymotic disease, approval be given to the appointment, at a salary of 500*l*. per annum, of a research bacteriologist." Since 1870, the board's hospitals have received more than 500,000 cases of infectious disease, with nearly 40,000 deaths. For one example of the national loss from these diseases, we have the fact that measles alone, in five years, in London, accounts for 10,199 deaths. We want to know more about measles. Probably it would pay the country to appoint more than one bacteriologist, at more than 500*l*. per annum, to study measles alone. We have looked at measles for ages, but have not found the cause of it. The discovery of the cause of diphtheria led to the discovery of diphtheria antitoxin. It is not improbable that some equally valuable discovery is waiting to be made in measles. Dr. Bousfield, at this meeting of the Metropolitan Asylums Board, put the matter in very plain words:—

"We have simply been warehousing infectious disease for years. We have been treating the symptoms and knew nothing about the disease itself. We have spent in forty years 15,000,000*l*., and we now ask that machinery may be set up by which the lives of patients will be saved and the period of their stay in hospital considerably shortened, with a consequent saving of expense to the ratepayers."

This recommendation, of course, was agreed to; and, so far, so good. For in all London there is no authority wiser or more beneficent than the Metropolitan Asylums Board. But what is the good of one bacteriologist? We hope that he will be only the thin end of a wedge of bacteriologists. We are tired of babies dying of measles, tired of our ignorance of the cause of measles. It may be nature's way of killing off the undesirables, but she kills off likewise many desirables, and we want the bacteriologists to take nature in hand.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

WHEN the British Association last met at Dundee in 1867 the president of Section E, Sir Samuel Baker, had but lately returned from his discovery of the Albert Nyanza. In his presidential address for 1912 Colonel Sir Charles Watson returned to the subject of the Sudan, pointing out how much and yet how little has been learnt since the time of Sir Samuel Baker. In 1869 Sir Samuel Baker was appointed by the Khedive Ismail governor of the country south of Gondokoro, with instructions to extend the Khedive's authority as far south as possible. Owing to the increase of the Sudd and the inadequacy of his forces, little was accomplished at his return in 1873. The same post was held from 1874 to 1876 by Colonel Gordon, who for three years from 1877 was governor-general of the whole Sudan. Pressure of administrative work lessened the opportunities of geographical discovery, and after 1881 the Sudan was closed to Europeans until 1898. Few know how limited is our knowledge of the Sudan even to-day. Small scale maps convey the impression that more is known than is really known, and whatever appears on a carefully engraved map comes to be accepted as true for all time. The course of the Blue Nile itself from Lake Tsana to Famaka, the upper waters of the Atbara, Rahad Dinder and Sobat, and the mountains from which they flow, still await exploration, while great areas of the level plains remain not only unsurveyed, but unvisited. A complete trigonometrical survey is out of the question for many years to come, and though there has been a wonderful increase in our knowledge, though the blank spaces will be gradually filled, the task of geographers in the Sudan is not even half-completed.

In the absence of the Director-General of the Ordnance Survey, Captain E. O. Henrici, R.E., read his paper on the international map, and exhibited the five sheets hitherto published. The discussion on this paper strongly supported the president's criticisms of the colour scheme, and a general feeling was manifested in favour of a black and white edition of the map.

A valuable paper by Mr. E. A. Reeves dealt with recent improvements in surveying instruments, including those which deal with astronomical observation, triangulation and levelling, such as lamps for theodolites, invar tape and reflecting levels, and also the latest instruments for plotting the facts observed, such as the stereo plotter, Orel's stereo-autograph, telescopic alidades, and the latest advances in photographic surveying. Great interest was shown in an exhibition of road-books and atlases which illustrated Sir H. G. Fordham's bibliography of British and Irish road-books and itineraries from Leland to Ogilby, from Ogilby to Cary, and in the last period from 1798 to about 1850, when railways made itineraries except Bradshaw unnecessary. This paper included some references to the road-books of France.

African geography was pursued further by Dr. Felix Oswald, who gave some of the results of his journeys between the Victoria Nyanza and the Kisii Highlands, and Mr. G. W. Grabham, who dealt with the country northward from Lake Albert. Mr. W. J. Harding King, in his paper on the Libyan Desert, pointed out that the sand dunes do not extend so far as was formerly supposed, since a large plateau, starting about 20 miles south-west from Dakkleh oasis and running west, banks up practically the whole of the dunes. Southward of this plateau is a sandy plain rising toward the south; the top of a hill in this plain was found to be 2150 feet above the sea. There are numerous fertile spots south of lat. 20° N. Ennedi is said to be full of Roman remains. Another desert paper was given by Mr. I. N. Dracopoli, who, in speaking of the Sonora Desert of Mexico, dealt with the physical features of the region and the characteristics of the Papago and Seri Indians.

Mr. P. Amaury Talbot gave his experiences of Southern Nigeria, especially in the forest belt lying between the coastal swamps and the grasslands of the interior. As the Yoruba and Ibo territory is better known, he paid most attention to the Cross River district and its ethnography—the Ododop or Korawp forest negroes, the Ojo and Uyanga and the Ekoi, a semi-Bantu people of a high type.

The Antarctic discussion, which occupied the Monday morning, was specially appropriate to Dundee; no fewer than four Antarctic vessels were actually lying in the harbour during the meeting. Sir Clements Markham, to whom with Sir John Murray the revived interest in the Antarctic is mainly due, confined his attention to the expeditions of Captain Scott, Mr. Mawson, and Captain Filchner. Dr. W. S. Bruce gave a full review of the configuration of the continent, both the coast and the interior, as at present known, and then discussed former connections with the southern continents, as suggested by the discoveries of the *Scotia*. Dr. R. N. Rudmose Brown, who opened the discussion, agreed in the main with Dr. Bruce's views of the continental structure. Dr. E. Marshall spoke of the work done by Sir Ernest Shackleton, and Dr. Hodgson of his experiences in the *Discovery*. Prof. Charles Chilton, of New Zealand, discussed the biological evidence for the former land connection with his country.

Two committees were appointed to report to the section at the 1913 meeting, one on the present state of geographical teaching in Scotland, and the other on the choice and style of atlas, textual, and wall-maps.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE proceedings of the Section of Physiology were characterised by two features: the first was that a large number of foreigners attended the meetings of the section, and the second was that a whole day was devoted to subjects bearing on psychology.

Three subjects formed the bases of discussions. One joint discussion on animal nutrition with the Section of Agriculture is described in the report, which appears elsewhere in this issue, of the proceedings of that section.

The second joint discussion on the physiology of aquatic organisms was held with the Section of Zoology. This discussion was opened by Prof. A. Pütter, who gave the arguments in favour of his hypothesis that aquatic animals frequently obtain their food material in dissolved form. By measuring the respiratory exchange it is possible to calculate the amount of organic matter oxidised, and the quantity of organic matter in the form of plankton can be determined. If the plankton is uniformly distributed there is not sufficient particulate material to account for the organic matter oxidised unless the animals deal with disproportionately large amounts of water. He has kept animals for long periods without solid food, and found that they gained in weight. In addition, he determined the amount of dissolved organic matter in sea-water, and found that it was sufficient to account for the respiratory exchange of the animals.

Prof. Benjamin Moore, F.R.S., on the other hand, stated that there was not sufficient dissolved organic matter to account for the respiratory exchange. He considered that the plankton is not evenly distributed, and that the animals, aided by their sense organs, forage for food. In order to show the great activity of the phyto-plankton in forming organic matter, Prof. Moore mentioned that he had found the sea-water to be more alkaline in August than in April. He attributed this change to the removal of carbon dioxide from the water. When one considers the great bulk of water concerned, the change in reaction must mean an enormous synthesis of organic compounds.

Prof. Fil. Botazzi added that the dissolved organic nitrogen in sea-water is not sufficient to nourish the animals, and that sea-water is almost neutral in reaction.

Dr. W. J. Dakin pointed out that plankton collections did not necessarily contain all the particulate food matter contained in the sea. Prof. Pütter had said that food was often absent from the alimentary canal, but this might be due to the rejection of food after the animal was caught. Dr. Dakin had frequently found food in the alimentary canal. He believed that although some animals may live on dissolved organic matter, others certainly ingested particulate matter.

Prof. Leonard Hill, F.R.S., spoke about the effect of high pressures of water on living tissues. Frogs can survive exposure to pressures of 300 atmospheres, but at 400 atmospheres their muscles become opaque and disorganised. Bacteria are killed when the pressure reaches 3000 atmospheres. Prof. Doflein pointed out that protozoa can live on dissolved organic matter, and that digestion causes the solution of all foods before they are absorbed. Dr. F. A. Dixey, F.R.S., stated that insects can construct organic substances from air, and hence sea animals may possibly form organic material from simple dissolved constituents. Dr. N. Annandale described the effect of food in altering the colour of a form of hydra from Bombay. When placed in an aquarium it takes food, and the colour changes. Prof. A. Dendy, F.R.S., considered that all work done on sponges can be discounted because they are usually mixed colonies of plants and animals. Therefore some of the experiments described by Prof. Pütter ought to be repeated with other animals.

The third discussion, on the relation of mind to body, was preceded by a paper by Prof. Max Verworn on the physiological basis of memory and abstraction. In this paper he stated that nerve cells increase in size by use, and that the strength of the nerve impulse depends on the size of the cell body. Thus a series of nerve cells which had not been used should act as a block by causing a gradual decrease in the strength of the nerve impulse until the impulse becomes too weak to pass from one cell to another; whilst a series of well-exercised cells should increase the strength of the impulse. Nerve impulses should therefore tend to be propagated along more frequented paths.

Prof. R. Latta opened the discussion by contrasting the Parallelist and Animist points of view. The former, recognising two independent systems which correspond point for point, involves an extension of the mechanical hypothesis to mind, in utter disregard of the fact that the mechanical hypothesis is founded on the necessity of excluding everything mental from the physical system. The latter insists on the recognition of a teleological factor in organism and mind, placed entirely outside the mechanical system, and requiring an endless series of miracles. His conclusion was that mind cannot be entirely separated from matter, and that the distinction between the physical and the psychical, the mechanical and the teleological, is a distinction within one and the same system.

Sir T. S. Clouston dealt with the effect of diseased conditions, thus emphasising the intimate connection of the structure and chemistry of the brain with the mental processes.

Dr. J. S. Haldane, F.R.S., emphasised that it is impossible to separate mind from the bodily structures, nor can physiological processes be separated from physical and chemical laws. His belief is that the body properly understood is the mind, and that the physical sciences treat of a one-sided aspect of reality. The line of development is that in which the organic extends so as to include the inorganic.

Dr. H. J. Watt maintained that before the problem of the mind-body relation can be raised, it is necessary to form a properly classified catalogue of psychological states, and to determine whether some satisfactory correlation cannot be found among known or possible physiological processes. He urged that the facts adduced by McDougall in favour of interaction are really compatible with the broader views of parallelism.

Dr. C. S. Myers held the most tenable hypothesis to be that of parallelism between neural and mental processes and products, coupled with the realisation that the same difficulties which beset the explanation of the course and nature of mental processes occur on the neural (physiological) side.

Prof. Geddes demonstrated by a diagram that the opposing views are really two aspects of the same thing, depending on whether the attention is fixed on the influence of the organism on the environment, or that of the environment on the organism. Prof. F. Geddes, F.R.S., and Prof. E. H. Starling, F.R.S., each considered that the discussion was premature, and they agreed with Dr. Watt that psychology must advance further before the subject can be profitably discussed. Prof. Leonard Hill, F.R.S., said that, in spite of our inability to reach a conclusion, the human mind seems prone to consider its relation to its environment, and that the present discussion was in deference to this propensity.

Two interesting demonstrations were given. Prof. Heger showed some kinematograph films illustrating the beating of the tortoise heart with the effect of poisons upon it, and the movements of the circulation in crustacea and the frog.

Prof. Leduc illustrated the effect of diffusion by placing drops of a watery suspension of Indian ink on a salt solution. He believes that cells represent dynamic centres which, by centrifugal and centripetal forces, produce the various appearances which we ascribe to cell structure.

Prof. F. Gotch, F.R.S.: In the dark adapted eye the peripheral portion of the retina is more sensitive than the fovea; red vision extends some distance beyond the fovea, but green is confined to it. A green light falling outside the fovea is recognised as a white glare. Owing to the peripheral portion being more sensitive, a feeble light disappears when it is fixed. Hence, after a light has been discovered at night, to distinguish white from green, night-glasses must be used in order to raise the luminosity above the threshold for the fovea.

Dr. Edridge Green criticised for three reasons the report of the Departmental Committee on Sight Tests. The retention of the wool test, the form of lantern, and method of flicker photometry recommended were condemned. In the subsequent discussion all who spoke condemned the wool test, but the form of lantern and flicker photometry were efficiently defended.

At one time an interesting discussion seemed imminent. After a paper by Prof. Hamburger on phagocytosis, Prof. Asher read a paper on cell permeability. The former demonstrated the ingestion of carbon by leucocytes, and described the effect of certain substances on the rate of phagocytosis. Some of these substances, he said, acted because of their action on the lipoid layer of the corpuscles. The latter described the changes in staining capacity brought about by activity in the glands of the nictitating membrane of the frog. These changes, he said, must be independent of any lipoid material surrounding the cells.

Prof. Fil. Bottazzi reported the result of a series of determinations of the physical chemistry of muscle plasma. Dr. Campbell and Prof. A. B. Macallum, F.R.S., found that certain cells of the kidney tubule stain blue after the injection of a mixture of iron and ammonium citrate and potassium ferrocyanide. These authors state that this change will take place only in the presence of acid, and that therefore the cells are excreting acid.

Dr. Cramer reported the results of some metabolism studies on tumour growth. For the same increase in weight transplanted tumours require less protein than does normal growth. Glycogen is used during the period of growth. If the glycogen metabolism is interfered with by thyroid feeding, the transplanted tumours do not develop. Drs. Cramer and Pringle: Thrombokinase from platelets will pass through a Berkefeld filter, but the thrombokinase from tissues will not pass through. Mr. S. Dawson found that brightness discrimination is more accurate with two eyes than with one. There is, however, no summation, as the apparent brightness is the same whether the object is viewed with two eyes or with one.

Prof. Max von Frey described the effect of two adjacent pressure stimuli on each other. A stimulus accompanying another apparently increases the intensity of the one stimulus. The location of two neighbouring stimuli is between the two and nearer to the stronger stimulus.

Prof. Ida Hyde in a series of papers gave the following results. Tripolar electrodes are more efficient and less injurious in blocking nerve impulses than other methods. Afferent impulses more easily blocked than efferent. Afferent fibres were found in the phrenic nerve. The action of alcohol on the cutaneous reflexes of the frog is depressent.

Prof. A. Kossel dealt with the problem whether the guanidine group was or was not free in lysin. He concluded that it was not free.

Prof. H. Kronecker dealt with the distribution of taste sensations. He concluded that compensation occurs in the central organ. Prof. O. Loewi found that strophanthine acts like calcium in antagonising the effect of potassium. Prof. A. B. Macallum, F.R.S., showed slides representing the distribution of potassium in cells. He believes that the distribution is the result of potassium causing a decrease of surface tension at the interface.

Prof. J. J. R. Macleod: Stimulation of splanchnic nerve or hepatic plexus causes hyperglycæmia. A second factor is necessary, namely, the presence of adrenaline. Dr. J. L. McIntyre stated that animals form mental images by which they remember places. Rev. James Marchant read a paper arguing that, instead of devoting our energies to the prevention of race degeneration, we ought to attempt race regeneration.

Prof. C. R. Marshall presented a series of pharmacological papers showing that:—(1) Quarternary ammonium bases act on myo-neural junction; methyl compounds are more active than ethyl compounds. (2) Nitric esters cause vasodilatation by acting on myoneural junction; relative activity corresponds with solubility except in the case of acid compounds, when the carboxyl group appears to exercise an inhibiting action; activity depends on ease of reduction to nitrites in alkaline solution. (3) Coriamyrtin and Tutin were contrasted.

Prof. T. H. Milroy concluded from his experiments that the gaseous exchange during apnœa is due to physical causes. Prof. F. H. Pike described the condition of the spinal vasomotor nerves in shock. Mr. H. Reinheimer stated that factors can be given to biological processes so that the value of an organism to the community can be computed in a similar way that factors in political economy enable general values to be calculated. Mr. W. Sack found that injection of extract of corpus luteum caused a retention of nitrogen in female rats, but not in males. This points to the action being upon the female generative organs.

Prof. W. H. Thompson investigated the output of nitrogen after administering arginine. The nitrogen was mainly excreted as urea and ammonia, but a certain amount was unaccounted for. The effect of simultaneous administration of methyl citrate on the excretion of creatin and creatinin was investigated.

Dr. C. W. Valentine concluded that the horizontal-vertical illusion is due to a retinal quality whereby equal lengths in the vertical direction are referred to greater distances than in the horizontal direction.

Prof. A. D. Waller, F.R.S., read an account of the nerves found in the trunk of an elephant which died near Dundee two hundred years ago. Patrick Blair secured the carcass and dissected until the remains became unfit for further work. He removed the trunk and made a dissection, as the result of which he described different nerves for movement, touch, and smell. The bones of this elephant were ultimately used as a fertiliser by a neighbouring farmer.

Prof. A. D. Waller, F.R.S., by means of the oscillograph, compared the electro-cardiogram with the pulse. He found that a deep inspiration may affect the pulse in two ways (*a*) by actually stopping the heart, and (*b*) by compression of the subclavian artery. Descent of the diaphragm diminishes the potential difference between the two hands, but increases that between the left hand and left foot.

All the reports and abstracts of papers received in sufficient time before the meeting were bound, and copies can be obtained at the British Association offices.

H. E. ROAF.

AGRICULTURE AT THE BRITISH ASSOCIATION.

IN drawing up their programme for the Dundee meeting, the organising committee of the section decided to concentrate attention on three or four subjects, of which one or two should be of distinct local importance. The method worked so well that it is likely to be adopted in future years. The subjects selected were milk problems, animal nutrition, the application of meteorological information to agricultural practice, and the sources of the nation's food supply.

In his presidential address, Mr. T. H. Middleton described the changes that have taken place in the development of agriculture during the past two hundred years, and the address, the main parts of which are printed in NATURE of October 24, p. 235, formed a fitting historical introduction to the work of the section. This was followed by a series of papers on milk. Mr. W. Gavin dealt in a very able paper with the interpretation of milk records. He pointed out that in any statistical study of the inheritance of milk yield, or indeed in any systemised breeding experiment where more than a few cows are dealt with, it becomes necessary to define a cow's milking capability by a single and unqualified figure. Breeders generally depend on such figures as total yield per calf, total yield per calendar year, average per week, &c., but the enormous fluctuations found in the same animal show that all these are subject to a variety of outside influences. Better results are obtained by a consideration of the maximum yield per day, the average yield per day during the fifth to twelfth week after calving, and the maximum yield per day maintained or exceeded for not less than three weeks.

Dr. Lauder and Mr. Fagan dealt with the effect of heavy root feeding on the yield and composition of milk; three experiments were made, each with eighteen to twenty-two cows, and the following conclusions were drawn:—(1) The feeding of a ration containing a large quantity of water does not increase the percentage of water in the milk or reduce the percentag of fat; (2) the larger yield of milk is obtained from the cows on the concentrated ration; (3) on the other hand, however, the milk from the cows on the turnip ration contained a higher percentage of fat and a greater total weight of fat. It was also noticed that much more fat was obtained in the milk than was given in the ration; thus the turnip ration contained 171 lb. digestible fat, while the milk contained 529 lb.

Messrs. Cooper, Nuttall, and Freak discussed the relationship between certain properties of the fat globules of milk and its churnability. A method was devised for determining the size of the globules, and a number of measurements have already been taken, but there seems to be very considerable variation in different milks of the same breed of cows. The question of a membrane surrounding the fat globule was studied, and an attempt was made to repeat Storch's work; no evidence could be obtained, however, in its favour, and the conclusion was drawn that the membrane does not exist.

The discussion on the nation's food supply was opened by Mr. R. H. Rew, C.B., who presented some interesting tables of statistics, and expounded them in his usual lucid manner. Perhaps the most striking conclusion is that the United Kingdom produces rather more than one-half of its total food requirements exclusive of sugar and beverages, such as tea and coffee, that cannot be grown in these islands. The home production is valued at about 180,000,000*l.* per annum, and the imports at 206,000,000*l.*, of which 39,000,000*l.* goes in sugar, tea, coffee, and cocoa. These figures came as a great surprise to the meeting, and it is certainly satisfactory to know that British agriculture has so well maintained its position in competition with other countries. In one commodity only is there any great falling off; we produce only one-fifth of the total wheat consumed. Under present systems of husbandry, wheat seems to be a pioneer crop produced in the new countries of the world.

Major Craigie followed with an interesting account of the development of Scottish agriculture during the past fifty years. Many thousand acres of grain, turnips, and potatoes have gone, but the area under rotation grasses has increased, while that under permanent grass has gone up very considerably; the yields also are all higher, especially of wheat and potatoes, the former having gone up from 28 to 41 bushels per acre, and the latter from 4 to 7 tons.

The joint meeting of the meteorological department of Section A, which was one of the prominent features of the programme, was described in NATURE of November 28, p. 369.

The second joint meeting was with Section I on animal nutrition. For the past ten years an important series of sheep and cattle feeding experiments has been carried out by Mr. Bruce, and the results were very ably summarised by Mr. Watson. A remarkable feature was the pre-eminent position of linseed cake as a food, animals fed on this always making greater progress than those on other substances. Better results were also obtained with Bombay cotton cake than with Egyptian cotton cake, in spite of their apparent identity on chemical analysis. A mixture of wheat, cottonseed and cotton cake made up to give the same analysis as linseed cake proved economically a failure. The conclusion is drawn that our present methods of valuing feeding stuffs do not afford particularly useful information. Prof. F. G. Hopkins dealt with the discrepancy. Until recently physiologists had been content to express diet in terms of energy and protein minimum, neglecting other factors. It is now known that these other factors do matter, and that one cannot group together all the constituents either in terms of a starch equivalent or of any other unit. There are other constituents just as important as carbohydrate, protein, or fat, and if these are removed the diet may lose much of its value or even predispose to disease. Dr. Funk gave an actual illustration in the work that he has been doing at the Lister Institute on the isolation of the so-called vitamine from rice polishings.

Prof. Leonard Hill described his experiments on the relative nutritive values of white and of standard bread as further illustrating the value of the subtle principles in the husk or coat of the grain. Standard bread proved the better food for rats and mice; indeed, white bread failed to maintain life. For the ordinary man, however, it is not necessary that bread should be a complete food owing to the variety of his diet, but for the poor it is undesirable that the valuable principles of the coats should be lost. This was followed by a practical paper by Mr. Ross, who emphasised the importance of individual attention to the animals. He described his own practice, which is admittedly very successful, and was recognised by the physiologists as very similar to sanatorium practice. In particular no check in growth is permitted; the animal is kept developing uniformly from his birth upwards.

Prof. Hendrick gave an account of his experiments showing that cottonseed oil and linseed oil may be substituted for butter fat in the rearing of calves. Up to the time of weaning, the whole milk proved the better diet, but later on the differences fell off, and at the time of slaughter there was no significant difference between the variously fed animals. Prof. Berry gave an exhaustive report on the feeding of dairy cows in the west of Scotland, and also in a second paper investigated the probable error of pig feeding experiments, which was found to come out at 13·8 per cent., a value identical with the 14 per cent. obtained by Prof. T. B. Wood. Dr. Crowther gave a very spirited defence of the starch equivalent; this is admittedly imperfect, but at any rate it represents the best criterion at present available for the chemist. The discussion was continued by Drs. Cathcart, Douglas, Wilson, and others.

Of the general papers, two by Dr. Hutchinson attracted considerable interest. Lime is found to act as an antiseptic in the soil and to exert the same partial sterilisation effects as are produced by volatile antiseptics or by heat. Thus it initially kills many of the bacteria and of the protozoa; later on there follows a very marked development of bacteria and consequent production of plant food. In the second paper experiments on nitrogen assimilation were described. It was shown that practically any plant residues added to the soil caused bacterial assimilation of nitrogen to set up, whilst sugar caused marked assimilation, particularly if the temperature was sufficiently high.

Prof. Berry gave an account of his analyses of the oat kernel, which have been carried out for several years past. So many have accumulated that it is now possible to distinguish several more or less well-defined groups in which the size of the grain and the thickness of the husk are related to the percentage of oil. Two interesting papers were contributed by Prof. Hendrick, one showing the composition of water draining from soils practically free from carbonate of lime, and the other emphasising the value as manure of waste carbonate of lime.

A new line of agricultural study was opened up by Dr. W. G. Smith and Mr. Crampton, in a paper on the influence of origin and topography on grass lands. This is one of the earliest applications of the new ecological knowledge to agriculture.

Mr. Collins contributed a paper on the evolution of hydrocyanic acid from linseed, and several papers of economic interest were read by other members.

THE PALETTE OF THE ILLUMINATOR FROM THE SEVENTH TO THE END OF THE FIFTEENTH CENTURY.[1]

IN the opening lecture given at the Royal Academy of Arts last year, Dr. Laurie dealt with the question of the history of the pigments used at various times by painters, bringing together such information as could be obtained by a literary inquiry. Since then he has made an examination with the microscope of a large number of illuminated manuscripts at the British Museum, the Advocates' Library, Edinburgh, and the Edinburgh University Library, from the seventh to the end of the fifteenth century. The result of this examination has made it possible to identify the larger number of pigments used, and classify them according to the centuries and according to different countries, Byzantine, Irish, French, English, Italian, and German manuscripts having been examined.

The general results are to show that during these centuries the palette was practically confined to vermilion, whether natural or artificial, red lead, orpiment, ultramarine and ultramarine ash, azurite, malachite, natural and artificial, verdigris, lakes, and preparations of the nature of Tyrian purple, with the addition of a remarkable transparent green used from the eighth to the fourteenth century, which owes its pigmentary value to copper, although it has not been possible to determine exactly the nature of the compound. A green closely resembling it in appearance and properties can, however, be prepared by dissolving verdigris in Canada balsam or other semi-liquid pine resins. In no case were any specimens of the Egyptian blue which was used so largely in classical times found on the manuscripts. It therefore seems probable that the method of manufacture of this copper silicate was lost before the seventh century.

In addition to these pigments, earth colours were occasionally used, and there are rarely present some pigments which it is difficult to classify. The lake used after the thirteenth century is closely matched by lac lake, which was introduced for dyeing purposes about that time, and on the manuscripts of the late fifteenth century a fine lake appears, which in one case has been identified with every probability as madder lake. The tests, however, cannot be regarded as absolutely conclusive.

No fresh light beyond that contained in the known records can be thrown on the mediums used, with the exception that on one later fifteenth-century manuscript the medium has been proved to be beeswax.

All the pigments mentioned on the above list were not used in the same countries at the same time. It is possible to show a gradual improvement, for instance, in the preparation of ultramarine from lapis lazuli. The use of a fine verdigris is not found until the beginning of the fifteenth century, and azurites of different quality appear and disappear at definite dates, while a marked distinction can be drawn between the palette used in Byzantium and Ireland, and that used in the rest of Europe from the tenth century. There are also remarkable examples of the use of gold dust, while the laying of golf leaf on raised gesso does not appear earlier than the eleventh century, and only becomes common in the twelfth century.

The whole result of the investigation is to settle with considerable exactness the actual pigments in use, and it is probable that the results will be of value in assisting in fixing the dates of doubtful manuscripts.

It will be noted that the pigments are almost entirely mineral in character. They are in all cases coarsely ground, and the decorative effect is largely due to the coarse crystalline particles resulting in a broken surface.

The detailed results of the investigation were laid before the Society of Antiquaries on November 28, and are being published by that society.

[1] Abstract of the opening lecture delivered at the Royal Academy of Arts on December 2 by Dr. A. P. Laurie.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—On November 28 the preamble of a statute supplementing the ordinary form of procedure in Convocation by providing in certain circumstances for a special poll was moved by Prof. Geldart, supported by the Master of Balliol, and opposed on various grounds by Prof. Oman, Prof. Myres, and the president of Corpus. A division in a thin house showed twenty-five in favour of the preamble and twenty-four against it.

Sir William Mitchell Ramsay has been appointed Romanes lecturer for 1913. His subject has not yet been announced.

THE prizes and certificates gained by students of the Sir John Cass Technical Institute during the past session will be distributed by Prof. Selwyn Image, Slade professor of fine art, Oxford University, on Tuesday, December 10, at 8 p.m.

IN reply to a question asked in the House of Commons on Monday, Mr. Wedgwood Benn said:—"The Government is under no promise to find a new site for the London University, and it is not intended to use part of the Botanic Gardens for this purpose."

IN the House of Commons on Tuesday, the Prime Minister was asked whether he was aware that in 1909 the Chancellor of Oxford University issued a memorandum urging the reform of Convocation and greater facilities for students of limited means, and that neither of these reforms had been attempted; and whether the Government was now prepared to advise that a Royal Commission be appointed to carry through those reforms. In reply, Mr. Asquith said:—"I am well aware of the importance of these matters and have given them much attention. I hope shortly to be able to make a definite statement on the subject."

THE Marquess of Northampton, K.G., will distribute the prizes and certificates at the Northampton Polytechnic Institute, Clerkenwell, to-morrow, December 6. The laboratories, workshops, &c., with various exhibits in them, will be open for inspection on that occasion, and also on Saturday evening. There will be kinematograph illustrations of twisting and breaking, by Mr. C. E. Larard; demonstrations with liquid air, by Mr. W. M. Wilcox; and an illustrated lecturette on notable bookbindings, by Mr. T. E. Harrison.

It is announced in *Science* that Mr. George F. Baker, president of the First National Bank of New York City, has given a large sum, reported to be 400,000*l*., to bring about an alliance between the New York Hospital and the Cornell Medical College. From the same source we learn that Dr. Arthur T. Cabot, a fellow of Harvard University, has bequeathed 20,000*l*. to the Harvard Medical School and the larger part of his estate, estimated at 100,000*l*., to Harvard University, after the death of Mrs. Cabot. It is reported also that from the estate of George Crocker, Columbia University receives 315,00*l*. for the Crocker Cancer Research Fund, and that at the University of Rochester 52,500*l*. has been contributed to the endowment fund by old students living elsewhere.

For some years past Prof. M. J. M. Hill, F.R.S., has been endeavouring to bring into general use a modification of Euclid's method of treating the theory of proportion, in which one of the two distinct methods which Euclid employs to prove his propositions is shown to be sufficient to prove them all. The indirectness and consequent difficulty of Euclid's proofs then disappear. He has set forth his ideas in some detail in the July and October numbers of *The Mathematical Gazette* of this year, and he has arranged to give ten lectures, specially devised to meet the needs of teachers, on the subject, at University College, Gower Street, after Christmas. The lectures will be delivered on Tuesdays at 6 p.m., commencing on January 14, 1913. They are in connection with the London County Council, and are open on payment of a registration fee of 1*s*. to all teachers in schools and other educational institutions in the administrative county of London. Application for admission to the lectures should be made by January 1.

The current session at University College, Nottingham, is the thirty-second since the foundation of the institution in 1881. The calendar for 1912–13, which has reached us, gives detailed information of courses of instruction for students desirous of graduating in one of the faculties of the University of London, and of classes arranged for technical instruction allied to the industries of the neighbourhood. The college confers the title of associate of University College, Nottingham, on students who have attended satisfactorily for three years any systematic degree or diploma course, and have passed the appropriate examinations, and on students who have passed the examinations of the three-years' course required by the Oxford and Cambridge Affiliation Scheme. College diplomas are awarded to those students who have followed the prescribed courses in engineering or mining, and passed the final examinations. Oxford and Cambridge affiliation certificates are awarded to students who, for three sessions, have received at least four hours' tuition weekly at the college, and have passed satisfactorily examinations approved by the University. The Universities of Cambridge and Oxford both grant certain privileges to students holding these certificates, who may subsequently enter either University. The diploma in mining has been approved by the Home Secretary for students qualifying for the Colliery Managers' Certificate.

A letter has been sent on behalf of the General Council of Edinburgh University to all the Scottish members of Parliament protesting against the action of the Treasury in respect of fees at the four Scottish universities. The Treasury has attached to the increased grants to the universities the condition that so far as class fees are concerned, an inclusive fee be substituted for the individual fees hitherto charged. In the statement addressed to the Scottish members of Parliament, we learn from *The Times*, the following paragraph occurs:—"In claiming that our ancient universities should be free we have no intention whatever of suggesting that they should not be required to give an account of how they spend public money. But the obligation to render such an account is a very different thing from the submission of the universities to the edicts of a State Department to which Parliament has assigned no right of interference with their internal affairs. The General Council protests against this extension of bureaucratic government to the Scottish universities. It is the first step towards a system which would in time destroy the true spirit of university education in Scotland." After reviewing French experience of State supervision of universities and contrasting it with the principle of academic freedom in German universities, the memorandum concludes:—"The plain teaching of history is not to be ignored. The universities of Scotland must remain free in respect both of their teaching and of their internal administration. The members of the General Council accordingly look with confidence to the Scottish members of Parliament to maintain this freedom, and to use their influence towards securing that the Treasury shall pay the grant to the universities, without deduction, and without conditions other than those laid down by Lord Elgin's Committee."

SOCIETIES AND ACADEMIES.

London.

Royal Society, November 21.—Sir Archibald Geikie, K.C.B., president, in the chair.—A. S. **Russell** and R. **Rossi**: An investigation of the spectrum of ionium. The arc spectrum of an active preparation of ionium oxide mixed with thorium, separated by Prof. B. B. Boltwood from the pitchblende residues loaned to Prof. Rutherford by the Royal Society, has been investigated with a large Rowland grating. The complete spectrum of thorium was obtained, but no new lines were observed that could be attributed to ionium. It was deduced that if ionium were half transformed in 100,000 years, the preparation should contain about 16 per cent. of ionium oxide. By adding cerium and uranium to the preparation, it was found that 1 per cent. of the former and 2 per cent. of the latter could be easily detected spectroscopically. It was consequently concluded that the period of ionium cannot exceed 12,000 years. This result, taken in conjunction with Soddy's results on the period of ionium, points to the existence of at least one new, comparatively long-lived body between uranium and ionium in the disintegration series.—J. A. **Gray**: A note on the absorption of β rays.—J. A. **Gray**: The similarity in nature of X and primary γ rays. (1) Absorption experiments show that there is no fundamental difference in the absorption of X and γ rays. (2) The primary γ rays of radium E excite the characteristic radiations (series K) of silver, tin, barium, cerium, praseodymium and neodymium. (3) The scattering of the primary γ rays of radium E is probably similar in character and magnitude to that of ordinary X-rays.—J. Crosby **Chapman**: The spectra of fluorescent Röntgen radiations. Radiations belonging to groups K L have been investigated as regards their X-ray properties. The absorption of the various radiations of both groups in copper, silver, and platinum has been found. In all cases it is shown that, if radiations from different groups suffer the same absorption in aluminium, then they are equally absorbed in any other element. Dr. Walter **Wahl**: Optical investigation of solidified gases. II., the crystallographic properties of hydrogen and oxygen.—R. E. **Slade**: An electric furnace for experiments *in vacuo* at temperatures up to 1500° C. This furnace was designed with a view to investigate, at temperatures up to 1500° C., certain cases of heterogeneous equilibrium in which the equilibrium is defined by the pressure of the system. Instances are the dissociation of oxides, nitrides, and carbonates and the reduction of oxides by carbon.—R. E. **Slade** and F. D. **Farrow**: An investigation of the dissociation pressures and melting points of the system copper—cuprous oxide. The melting point (temperature, composition) diagram of the system copper—cuprous oxide has been constructed. The following are the principal points:—Melting point of copper 1083°. Eutectic Cu_2O 3·5 per cent., Cu 96·5 per cent., 1065° (determined by Heyn). Two liquid phases appear at 1195°, the denser one having the composition Cu_2O 20 per cent., Cu 80 per cent., and the lighter one Cu_2O 95 per cent., Cu 5 per cent. Melting point of cuprous oxide 1210°. The critical temperature at which the two liquid systems become identical is too high to be determined.—Dr. A. **Russell**: Note on the electric capacity coefficients of spheres. In connection with Mr. Jeffery's paper published in vol. lxxxvii. of the Proceedings, p. 109, the author gives and refers to formulæ by means of which the values of the capacity coefficients of equal spheres can be easily found. He uses these formulæ to check the tables given in Mr. Jeffery's paper.—W. J. **Harrison**: The motion of viscous liquid due to uniform and periodic motion maintained over a segment of an infinite plane boundary.—Prof. B. **Hopkinson** and G. **Trevor-Williams**: The elastic hysteresis of steel. A bar of steel, the reduced portion of which is 4 in. long by ¼ in. diameter, is subjected to alternating stress in the high-speed fatigue-testing machine described in a previous communication. This machine gives direct axial stress up to range of 30 tons per square inch or more, between equal limits of tension and compression, at a rate of about 120 cycles per second. The elastic hysteresis is measured by determining, with the aid of thermo-couples, the fall of temperature between the centre of the piece and each end when it is undergoing alternating stress within the elastic range. The dissipation of energy corresponding to a given fall of temperature is determined by heating the specimen with an electric current and measuring the watts dissipated by resistance. In the mild steel used in the experiments the energy dissipated per cycle when the limits of stress are $\pm 12\frac{1}{2}$ tons per square inch (giving a range of 25 tons, which is within the limiting elastic range as determined by ordinary fatigue experiments) is about 25,000 ergs per c.c., and gives a fall of temperature of about 5°. This is of the same order of magnitude as that due to the magnetic hysteresis in similar material under strong magnetic forces. The elastic hysteresis varies approximately as the fourth power of the stress range.—W. R. **Bousfield**: Ionic size in relation to molecular physics, together with a new law relating to the heats of formation of solid, liquid, and ionic molecules. In a former paper it was shown that ionic volumes (derived from mobilities) and solution volumes were connected by an empirical linear relation.

$$EV_s = a - bI_v.$$

In the present paper a new empirical relation is established of the form

$$D^{-1} = p - qN(I_v - K),$$

where D is the effective molecular freezing point depression, i.e. $\Delta/N(1+a)$. In the former paper the experimental data were given for KCl and NaCl, and in the present paper for LiCl, which data determine the constants *a*, *b*, *p*, *q*, for each salt. It is now shown that we can express in terms of these constants—(1) The factor required to reduce arbitrary ionic volume units to absolute units; (2) the volume of the ionic nuclei; (3) the volume and mean density of the "watery atmospheres" associated with the ions. It is shown for a group of fourteen solid and liquid salts and acids that their heats of formation are given by the expression $7/8\delta V + H_1 + H_2$, where δV is the reduction of volume (or contraction) which takes place on combination, and H_1 and H_2 are constants for the elements of which they are composed. It is found that the heats of ionisation of the three salts may also be expressed under the same law as

$$\Sigma 7/8\delta V + H_1 + H_2 + 1{\cdot}3n - 29$$

where δV includes volume change of combined water as well as of ionic nuclei, *n* is number of molecules of combined water and −29 is a constant which represents endothermic changes involved in ionisation.—Dr. J. Emerson **Reynolds**: The synthesis of a silicalcyanide and of a felspar. During recent years the writer has obtained many compounds of silicon in which that element is directly united with the nitrogen of various organic groups, and amongst these silicocyanogen, SiN, in combination. The proof so obtained that silicon has a strong attraction for trivalent nitrogen in organic substances suggested that a similar capacity is operative in the mineral kingdom, but in respect of trivalent aluminium acting in the nitrogen rôle towards silicon. It seemed probable that some at least of the more important rock-forming minerals may be regarded as fully oxidised products of alumino-*silicides* somewhat analogous to SiN. The experimental work recorded in the paper supports this view, and has resulted in the formation of a remarkably stable substance termed *Calcium Silicalcyanide*, $Ca(SiAl)_2$, analogous to ordinary calcium cyanide, $Ca(CN)_2$. From this silicalcyanide a further synthesis of the felspar *Anorthite*, $CaSi_2Al_2O_8$, has been effected.—Prof. C. **Niven** and A. E. M. **Geddes**: A method of finding the conductivity for heat.

Royal Microscopical Society, November 20.—Mr. H. G. Plimmer, F.R.S., president, in the chair.—E. **Heron-Allen** and A. **Earland**: The distribution of *Saccammina sphaerica* (M. Sars) and *Psammosphoera fusca* (Schulze) in the North Sea, with particular reference to the suggested identity of the two species. These Foraminifera, belonging to the family Astrorhizidæ, and originally described as from the North Sea, but occurring also in all the great oceans, have been the subject of considerable controversy. Dr. Ludwig Rhümbler asserts that Psammosphœra is only an immature stage of Saccammina. As a result of the examination of about 150 dredgings made in the North Sea, the authors have no hesitation in affirming that the life-history of Saccammina, as recorded by Rhümbler, is a composite sketch, involving three separate and generally recognised specific organisms: Stages I. to III. represent the life-history of *Crithionina mamilla* (A. Goes); stage IV. is *Psammosphoera fusca* (Schulze), an extremely variable species, which occurs both free and sessile, but is in all its stages normally recognisable by the absence of a general aperture; stages V. to VII. represent the complete life-cycle of *Saccammina sphaerica* (Sars), so far as it is a shell-bearing organism. Rev. Hilderic **Friend**: British Henleas. The Henleas are microscopic annelids belonging to the family of Euchytræids. The genus was created in 1889 by Michaelsen, and contained four authentic species and four which were doubtful. The present paper gives an enumeration of no fewer than nineteen species, eighteen of which are found in England and one in Ireland. Of these, seven new to science were found at Hastings in December last, and three have been found in Nottingham during the present year.—J. **Murray**: African

Tardigrada. This paper adds thirteen species to the list of African Tardigrada; twelve were described in the author's previous paper, and Daday added a new species, *M. tetronyx*.

Institution of Mining and Metallurgy, November 21.—Mr. Edward Hooper, president, in the chair.—Allan J. **Clark** and W. J. **Sharwood**: The metallurgy of the Homestake ore. The round of operations after delivery of the mined ore to the mill bins may be summarised briefly as follows:—The ore is fed to mortars fitted with one inside amalgamation plate, when it is crushed wet by gravitation stamps and thence passes over a series of amalgamating plates. A special cone system separates a small proportion of the coarsest sand, which is reground and returned. A system of cone classifiers, the last of the series provided with bottom water feed, separates successive portions of the fine slime. The sand is collected, drained, and treated with cyanide solution, in vats from which the residues are discharged by sluicing. The slimes overflowing the various cones are thickened in classifying tanks having conical bottoms and peripheral overflow, and the thickened slime is conveyed by a pipe line to a cyanide plant, where it is collected and treated in filter presses, which are discharged without opening by means of an automatic sluicing device. Solutions are precipitated by zinc dust. Concentration proper is not practised, and no ore is sorted. From the time the ore leaves the mine, no elevation is necessary, and only a small proportion of the water has to be pumped back at certain stages. Of the total ore value 94 per cent is recovered, about 72 per cent. as amalgam, and 22 per cent. by the cyanide process.—J. W. **Ashcroft**: The flotation process, as applied to the concentration of copper ore at the Kyloe Copper Mine, New South Wales. An adjourned discussion on this paper, which had been introduced at a previous meeting, gained additional interest from the fact that a working model of the particular flotation process referred to in the paper was exhibited, and samples of well-known ores were treated before the members present.

CAMBRIDGE.

Philosophical Society, November 11.—Sir J. J. Thomson in the chair.—Sir J. J. **Thomson**: The theory of the motion of charged ions through gases. Dr. G. F. C. **Searle**: A simple method of determining the viscosity of air. Air is compressed into a vessel of volume S c.c. (about 10 litres) and is then allowed to escape through a capillary tube of length l cm. and radius a cm. into the atmosphere, the pressure of which is P dynes per sq. cm. The pressure in the vessel falls from p_1 to p_2 during t secs. Over a considerable range of initial pressure the value of t/λ is found to be constant. The temperature of the air in the vessel is maintained nearly constant by the surrounding atmosphere. The method is convenient as a rough and ready method in a large practical class.—R. **Whiddington**: Note on the Röntgen radiation from kathode particles traversing a gas. During some experiments with a lime kathode it was noticed that even when the beam of kathode particles was not permitted to strike a target a comparatively strong radiation could be detected, proceeding apparently from the path of the kathode particles. The evidence goes to show that this is a Röntgen radiation arising from the encounters taking place between the kathode particles and the molecules of the residual gas within the discharge tube. It has been shown that a metal plate insulated and exposed to the action of these rays may charge up positively, emitting negative particles of very nearly the same velocity as the kathode particles traversing the discharge tube. The potential applied to the discharge tube varied in these experiments between 90 and 300 volts.—W. L. **Bragg**: The diffraction of short electromagnetic waves by a crystal. The paper deals with the interference phenomena observed by Herren Friedrich, Knipping, and Laue when a crystal is traversed by a narrow beam of rays from an X-ray bulb. The theory which is put forward by Laue to account for these phenomena postulates the existence of definite wave-lengths in the incident radiation, in order to explain the interference pattern of spots obtained. The paper shows that, on the contrary, the pattern obtained with the crystal of cubical zinc blende used by Laue is in reality the most general one possible for a continuous range of wave-lengths in the incident radiation, if the arrangement of atoms in the crystal is in accordance with the theory of valency volumes of Pope and Barlow. The incident radiation is regarded as a series of independent pulses, and the interference maxima as formed by reflection of these pulses in ideal planes in the crystal in which the atoms can be arranged, this point of view leading to greater simplicity of calculation.—H. E. **Watson**: Experiments on the electrical discharge in helium and neon.—H. C. **Pocklington**: Some diophantine impossibilities.—G. N. **Watson**: A class of integral functions defined by Taylor's series.—A. J. **Berry**: Notes on the volatilisation of certain binary alloys in high vacua. Experiments have been performed on the behaviour of certain binary alloys when heated in high vacua with the object of isolating intermetallic compounds (compare Roy. Soc. Proc., 86A, 1911, 67). In the case of alloys of copper and cadmium it was found that these two metals are quantitatively separable. When alloys of cadmium and magnesium are heated *in vacuo*, both metals volatilise together, but no definite relation between the composition of the residue and the distillate was established. The behaviour of the magnesium lead alloys indicates that the compound Mg_2Pb is largely dissociated in the vaporous state.

MANCHESTER.

Literary and Philosophical Society, October 29.—Prof. F. E. Weiss, president, in the chair.—Dr. Kurt **Loewenfeld**: Importance of autograph documents in the history of science (part i.). The author dealt with the usefulness of historical studies for the student of natural history, and the value of such studies for education as a whole. The documents exhibited and discoursed upon included many connected with John Dalton, the last table of atomic weights as drawn up by Dalton, between 1818 and 1827, amongst others; also letters by William Henry. A letter by Charles William Henry, inasmuch as it contradicts a statement in his own biography of Dalton, proves that he is not a trustworthy historian, and, as Charles William Henry's biography supplies some of the most valuable material for the important question of the genesis of the atomic theory, Dr. Loewenfeld considered this incident of importance.

DUBLIN.

Royal Irish Academy, November 11.—Count Plunkett, vice-president, in the chair.—W. J. **Dakin** and Miss **Latarche**: The plankton of Lough Neagh. The paper gives the results of the first detailed quantitative plankton research carried out on the lakes of the British Islands. Owing to the large area of the lake surface and the moderate depth (40 ft.) Lough Neagh is of particular interest. It is already famous for the presence, in very large numbers, of the Schizopod *Mysis relicta*. The authors have traced the seasonal development and interrelation of both the animals and plants by means of quantitative catches made at frequent intervals throughout a year. The seasonal variation is compared with that known for various European lakes. An interesting resemblance of Lough Neagh to the Danish lakes is discussed, and the contrast between the plankton of the Scottish lakes and Lough Neagh treated. The investigation has shown that so far as both the animals and plants are concerned Lough Neagh plankton contains a mixture of Arctic and Central European forms. Seasonal *form* variation has been observed in the case of several species, and the whole question of form variation is discussed. The authors cannot accept the Wesenburg-Lund-Ostwald theory that changes in shape in pelagic organisms are called forth directly by changes in the viscosity of the water. *Mysis relicta* has been found in thousands in the *surface* water of the lake at midnight. It was not previously known that *M. relicta* was a common plankton form.—Rev. T. **Roche**: The quadratic vector functions. The most general form of the quadratic vector function is taken to be

$$\alpha S\rho\phi_1\rho + \beta S\rho\phi_2\rho + \gamma S\rho\phi_3\rho,$$

ϕ_1, ϕ_2, ϕ_3 being symbols of linear vector functions, which may be taken as self-conjugate. A discussion on the properties of the function $k_1\phi_1 + k_2\phi_2 + k_3\phi_3$ is prefixed by way of introduction. Some very interesting relations are found between the invariants and associated functions of three linear functions. Then an attempt has been made to classify the functions, cases of degeneration to binomial and monomial forms are examined, and a few paragraphs have been added on the problem of inversion. The general problem does not seem capable of a solution; two particular cases are worked out fully. The number of roots for which the function vanishes has been investigated, this problem being a special case of the general problem of inversion. The last paragraph deals with the "central axes" of the quadratic function.—In connection with the Clare Island Survey the following reports were read:—G. H. **Carpenter**: Pycnogonida.—W. F. **Johnson**: Myriopoda.—A. D. **Cotton**: Marine algæ, part ii.—P. H. **Grimshaw**: Diptera. This paper embodies the results obtained from the examination of more than 4000 specimens collected mainly during the summer months of 1910 and 1911. The number of species identified is 519, of which 160, or rather more than 30 per cent., are new to the fauna of Ireland. Some forty-four families are represented, and five species are new to Britain. Critical remarks are made regarding several of the species in the more difficult families, *e.g.* the Tendipedidæ (Chironomidæ) and the Anthomyiidæ, and it is hoped that such will prove an aid to future workers. The fauna of Clare Island includes, as at present known, 211 species, as compared with 476 recorded from the adjacent mainland. The species common to the island and the mainland number 168, while forty-three are recorded from the island alone.

CAPE TOWN.

Royal Society of South Africa, October 16. Dr. T. **Muir**: Note on double alternants.—Dr. T. F. **Dreyer**: *Xenopus laevis* (the Plathander).—J. **Walker**: A short note on the occurrence of Aspergillosis in the ostrich in South Africa. The occurrence of Aspergillosis in the ostrich is recorded, and the author believes this to be the cause of mortality in chicks and to a less extent in adults. The fungus concerned was *Aspergillus fumigatus*. The seat of lesions is principally the lungs (pneumomycosis).—Dr. J. R. **Sutton**: A preliminary survey of the meteorology of Kimberley. A contribution to a study of the meteorology of the tableland of South Africa. An account is given of the principal meteorological elements of Kenilworth (Kimberley), all of which, with the exception of the rainfall, are expressed in deviations from the normal monthly means derived from observations made during the last fifteen years.—C. **Moorsom**: Some geodetic elements.—Dr. E. S. **Goddard** and D. E. **Malan**: (1) South African Oligochæta. Part i., a Phreodrilid from Stellenbosch Mountain. The anatomy of a new genus of *Phreodrilid oligochaeta* is described, and constitutes the first record of the family in Africa. The specimens were obtained on the top of Stellenbosch Mountain. The new genus—Gondwanædrilus—is of interest since its occurrence in Africa completes the circumpolar distribution of the family. Its anatomy is important since it fills in the last gap in the series of peculiar relations of the spermathecæ, and leads to an understanding of modifications such as the "autospermatheca" of Phreodriloides—an Australian form.—(2) Part ii., description of a new species of Phreodrilus. An account of a new species of Phreodrilus taken on Table Mountain. It is interesting since it is related to *P. beddardi* and *P. subterraneus*. The peculiar anatomical features concern the dorsal position of the spermathecal pores, and a large hollow penis. The new form suggests that Phreodrilus is the central type of the family. (3) Contributions to knowledge of South African Hirudinea. Part ii., some points in the anatomy of *Marsupiobdella africana*. An account of the anatomy of Marsupiobdella, a new Glossiphonid leech, with a large internal brood pouch. The main points are concerned with the distortion and displacement of the digestive, nervous, and reproductive systems by the great development of the brood pouch.—Dr. L. **Péringuey**: Portuguese commemorative pillars erected on the South African coast. During the reign of John II., King of Portugal, the Portuguese navigators sailed for the first time provided with commemorative pillars, or "Padraos" to be erected at the furthest point reached. Diogo Cam is the first of these navigators who left Portugal with these regulation pillars. Portuguese historians attribute to him the erection of three, the most southern of which, erected at Cape Cross in 15° 40′ S. in 1486, was rediscovered in 1893. But the old chroniclers are not clear about the number of Padraos erected by Bartholomew Dias, and hitherto three only were mentioned, whereas it would appear that he put up five. Of all these pillars two only are now known to be in existence, Cam's pillar at Cape Cross, and a fragment of the Padrao Santiago, from Angra Pequena, is in the Cape Museum. The object of this note is to direct attention to the possibility of finding some remnants of the others.

BOOKS RECEIVED.

Smithsonian Institution. Bureau of American Ethnology. Bulletin 52: Early Man in South America. By A. Hrdlička and others. Pp. xv+405. (Washington: Government Printing Office.)

The Ways of the Planets. By M. E. Martin. Pp. v+273. (New York and London: Harper and Brothers.) 5*s.* net.

Le Origini Umane. By G. Sergi. Pp. xi+202. (Torino: Fratelli Bocca.) 3.50 lire.

Le Principle du Mouvement des Eaux Souterraines. By J. Versluys. Dutch translation by F. Dassesse. Pp. 147. (Amsterdam: W. Versluys.) 7 francs.

In the Shadow of the Bush. By P. A. Talbot. Pp. xiv+500+plates+map. (London: W. Heinemann.) 18*s.* net.

New Trails in Mexico. By C. Lumholtz. Pp. xxvi+411. (London: T. Fisher Unwin.) 15*s.* net.

A Systematic Course of Practical Science for Secondary and other Schools. By A. W. Mason. Book I. Pp. vi+126. (London: Rivingtons.) 1*s.* 6*d.* net.

Lehrbuch der Paläozoologie. By Prof. E. F. Stromer v. Reichenbach. II. Teil, Wirbeltiere. Pp. viii+325. (Leipzig and Berlin: B. G. Teubner.) 10 marks.

Die erklärende Beschreibung der Landformen. By Prof. W. M. Davis. German edition by Dr. A. Rühl. Pp. xviii+565. (Leipzig and Berlin: B. G. Teubner.) 11 marks.

Lehrbuch der Physik für Mediziner und Biologen. By Prof. E. Lecher. Pp. vii+451. (Leipzig and Berlin: B. G. Teubner.) 8 marks.

The Doctor's Dog: a Poem against Vivisection. By R. Dailey. Pp. 62. (London: G. Allen and Co., Ltd.) 1*s*. net.

Index Zoologicus. No. II. Compiled (for the Zoological Society of London) by C. O. Waterhouse and edited by D. Sharp. Pp. iv+324. (London: The Zoological Society of London.) 15*s*.

The Principles of Applied Electrochemistry. By Dr. A. J. Allmand. Pp. x+547. (London: E. Arnold.) 18*s*. net.

Electroplating. By W. R. Barclay and C. H. Hainsworth. Pp. viii+399. (London: E. Arnold.) 7*s*. 6*d*. net.

Astronomy. By G. F. Chambers. Pp. xxiv+272+plates. (London: Hutchinson and Co.) 5*s*. net.

The Infancy of Animals. By W. P. Pycraft. Pp. xiv+272+plates. (London: Hutchinson and Co.) 6*s*. net.

The Essentials of Physics. By Prof. G. A. Hill. Pp. viii+346. (London: Ginn and Co.) 5*s*.

Elementary Applied Chemistry. By L. B. Allyn. Pp. xi+127. (London: Ginn and Co.) 3*s*.

New Analytic Geometry. By Profs. P. F. Smith and A. S. Gale. Pp. x+342. (London: Ginn and Co.) 6*s*. 6*d*.

Daytime and Evening Exercises in Astronomy. By Dr. S. F. Whiting. Pp. xv+104. (London: Ginn and Co.) 3*s*. 6*d*.

The Scientist's Reference Book and Diary, 1913. (Manchester: J. Woolley, Sons and Co., Ltd.)

A Course of Elementary Practical Physics. By H. V. S. Shorter. Part i., pp. 111; part ii., pp. 216. (Oxford: Clarendon Press.) 2*s*. and 3*s*. respectively.

The "Wellcome" Photographic Exposure Record and Diary, 1913. (London: Burroughs, Wellcome and Co.)

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 5.

ROYAL SOCIETY, at 4.30.—A Gregarine, *Steinina rotundata*, nov. sp., present in the Mid-gut of Bird Fleas of the Genus Ceratophyllus: Dr. J. H. Ashworth and Dr. T. Rettie. (1) The Size of the Aorta in Warm-blooded Animals and its Relationship to the Body Weight and to the Surface Area expressed in a Formula; (2) The Size of the Trachea in Warm-blooded Animals and its Relationship to the Weight, the Surface Area, the Blood Volume and the Size of the Aorta: Prof. G. Dreyer, W. Ray, and E. W. A. Walker.—Studies of the Processes Operative in Solutions. (1) The Conversion of Ammonic Cyanate into Urea, especially as Influenced by Alcohols: E. E. Walker; (2) The Hydrolysis of Cane Sugar by Dilute Acids; (3) The Hydrolysis of Cane Sugar by Sulphuric Acid, with a Note on Improvements in Polarimetric Apparatus; (4) The Hydrolysis of Methylic Acetate by Acids: F. P. Worley; (5) The Nature of Hydrolytic Process: Dr. H. E. Armstrong and F. P. Worley.—The Direct Production of Characteristic Röntgen Radiations by Kathode Particles: Dr. R. T. Beatty.—The Penetrating Power of the γ Rays from Radium C: A. S. Russell.—The Photo-electric Behaviour of Iron in the Active and Passive State: Dr. H. S. Allen.—A Determination of the Radiation Constant: H. B. Keene.—Physiological Observations made on Pike's Peak, Colorado, with Special Reference to Adaptation to Low Barometric Pressures: C. G. Douglas, Dr. J. S. Haldane, Y. Henderson and E. C. Schneider.—Notes on the Life History of *Trypanosoma gambiense*, with a Brief Reference to the Cycles of *Trypanosoma nanum* and *Trypanosoma pecorum* in *Glossina palpalis*: Muriel Robertson.

LINNEAN SOCIETY, at 8.—Notes on Two Orchids New to East Sussex, and on several Rarer Species of Orchidaceæ: E. J. Bedford.—The Hebridean Diagona described as "Syntethys," and other Exhibits from the Cruise of the S.Y. *Runa* in 1912: Prof. W. A. Herdman.—Nature Camera Work, an Attempt to Combine Photography with Drawing in Body-colour: Miss Maud Umfreville Clarke.—Coloured Drawings of South African Plants: Miss Mary W. Johnstone.

SOCIETY OF DYERS AND COLOURISTS, at 7.30.—The Fellmongering of Sheep Skins and its Bearing on Leather Dyeing: M. C. Lamb.

MONDAY, DECEMBER 9.

ROYAL SOCIETY OF ARTS, at 8.—Methods of Economising Heat: C. R. Darling.

TUESDAY, DECEMBER 10.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Ancient and Modern Nubas: D. E. Derry.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Generation and Distribution of Producer-gas in South Staffordshire: H. A. Humphrey.

FARADAY SOCIETY, at 8.—The Electromotive Forces of Concentration Cells: Principal A. P. Laurie.

WEDNESDAY, DECEMBER 11.

ROYAL SOCIETY OF ARTS, at 8.—Natural and Synthetic Rubber: Dr. F. Mollwo Perkin.

AERONAUTICAL SOCIETY, at 8.30.—The Mathematical Theory of Aëroplane Stability: E. H. Harper.

THURSDAY, DECEMBER 12.

MATHEMATICAL SOCIETY, at 8.—Recent Advances in the Theory of Surfaces. Address by the ex-President (Dr. H. F. Baker), postponed from the November Meeting.—A Connection between the Functions of Hermite and Jacobi: H. E. J. Curzon.—The Equations of the Theory of Electrons Transformed Relative to a System in Accelerated Motion: H. R. Hassé.—The Convergence of Series of Orthogonal Functions: E. W. Hobson.—The Determination of the Nature of a Function from a Knowledge of One of its Derivatives: W. H. Young.—Mersenne's Primes: J. McDonnell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—A Single Phase Motor with Pole Changing Windings: J. S. Nicholson and B. P. Haigh.

ROYAL SOCIETY OF ARTS, at 4.30.—Delhi, the Metropolis of India: Sir Bradford Leslie, K.C.I.E.

CONCRETE INSTITUTE, at 7.30.—The Effects on Concrete of Acids, Oils and Fats: Robert Cathcart and Laurence Gadd.

FRIDAY, DECEMBER 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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NATURE

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

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Registered as a Newspaper at the General Post Office.]

THURSDAY, DECEMBER 12, 1912.

VEGETATION STUDIES IN THE NEW WORLD.

Die Vegetation der Erde. Sammlung pflanzengeographischer Monographien. Edited by Prof. A. Engler und Prof. O. Drude. XII., Die Pflanzenwelt der peruanischen Anden in ihren Grundzügen dargestellt. By Prof. A. Weberbauer. Pp. xii + 355. Price 20 marks. XIII., Phytogeographic Survey of North America. A Consideration of the Phytogeography of the North American Continent, including Mexico, Central America, and the West Indies, together with the Evolution of North American Plant Distribution. By Prof. J. W. Harshberger. Pp. lxiii + 790. Price 40 marks. (Leipzig: W. Engelmann, 1911.)

THE two last volumes to be added to Drs. Engler and Drude's series of plant geographical monographs deal with the vegetation of the Peruvian Andes on the one hand, and that of North and Central America and the West Indies on the other. The field in both cases is vast, and Prof. Harshberger's volume is of considerable bulk. Dr. Weberbauer's volume can scarcely be considered a worthy successor to the able monograph prepared by Dr. Reiche on plant distribution in Chile (vol. viii. of this series, published in 1907), which is all the more a matter of regret since the Peruvian Andine flora is one of particular interest. A good account of the vegetation of this region, in its relation to that of Chile and Argentina in the south and Ecuador to the north, still requires to be written.

Both volumes are excellently printed and illustrated, and by the illustrations alone Dr. Weberbauer's book fulfils a certain purpose.

A work on the flora of the Peruvian Andes labours under the initial disadvantage of dealing with only a portion of a vast tract of connected country stretching from Chimborazo to the Straits of Magellan. Moreover, since Peru lies so much nearer the equator, the vegetation is much less homogeneous in character than is the case in Chile. Four distinct botanical regions are included in Peru, each of which demands separate treatment, and the affinities of which lie rather in the longitudinal direction—that is to say, with similarly situated regions of countries to the north and south—than in the transverse. These regions are the coast flora; the middle region, often desert in character; the alpine-Andine flora of the western and central Cordillera, and the flora of the moist eastern slopes of the Andes.

The alpine region may be considered to extend from about 10,000 feet to the limits of vegetation on the western Cordillera, and to include the western slopes of the eastern range. Its flora is in direct continuation with that of northern Argentina and Chile, and is remarkably distinct and characteristic, showing very little relationship to that of the lower western slopes, and still less to that which is found as soon as the crest of the eastern Cordillera is crossed.

This highly-specialised nature of the high Andine flora was fully appreciated by Weddell, and it would have been far more valuable had the "Chloris Andina" been continued first, and a generalisation on the Andine flora as a whole followed in due course. Much still requires to be done in the careful study of the extensive collections of South American plants in European herbaria, and then another Hooker will be needed to give us a masterly review of the vegetation of the Andes as a whole.

The volume under discussion follows the general plan of the series. The physical geography of the region is first dealt with; then follows a short second part in which the characteristics of the different natural orders found in Peru are mentioned, as well as conspicuous genera, &c. In Part iii. the general character and distribution of the vegetation is described, and its zones are indicated and discussed in detail.

The inclusion of the flora of the tropical eastern slopes, which is so Brazilian in its affinities and so different from the rest of the vegetation, seems almost out of place in a work on the Peruvian Andes and cannot be rightly understood without careful comparison with the flora of western Brazil. Dr. Weberbauer's book, taken as a whole, suffers from being more of the nature of an account of his own travels rather than a general treatise. He has travelled far and wide in the Cordillera, and has proved himself to be an admirable collector; but, valuable as is his work in many respects, it does not appear, from the volume under review, that he has thereby constituted himself the proper person to write a comprehensive work on the flora of Peru.

The task undertaken by Prof. Harshberger is even more vast than that of Dr. Weberbauer, and the result is the accumulation of an immense amount of material which has often been but poorly digested. German readers are to be congratulated on being presented with an extract by Prof.

Drude of fifty pages, in lieu of the 700 which have to be faced by English-speaking botanists. The main portion of the volume consists of four parts: "History and Literature of the Botanic Works and Explorations of the North American Continent"; "Geographic Climatic and Floristic Survey"; "Geologic Evolution, Theoretic Considerations and Statistics of the Distribution of North American Plants," and "North American Phytogeographic Regions, Formations, Associations." Following the American custom, the author leaves out the normal "al" ending of adjectives wherever possible, with unpleasant results. The book consists very largely of extracts taken from the many papers mentioned in the voluminous bibliography, and taken with very little discrimination or critical examination. In consequence, there is a sad mixture of good, bad, and indifferent. For example, the statement that Vallisneria occurs "in the sea in a tangled mass" off Newfoundland is inserted without comment, when, as is well known, it is a fresh-water plant, and *Zostera marina* is the plant in question. Many similar examples of the inclusion of erroneous statements from unworthy sources might be given.

From the way the volume is pieced together it is not possible to gain any vivid impression of the flora of North America as a whole. There is no broad generalisation based on the information which has been so laboriously collected, but the subject-matter tends to be broken up into minutiæ of detail.

As an example of the way in which the book is made up of information somewhat indiscriminately pieced together, it may be mentioned that the author quotes himself by name as the authority for some of his own statements on p. 381.

The whole of North America is divided up into zones, sections, regions, areas, formations, &c., and it is not possible to discuss here the accuracy or otherwise of the citations from which the information is built up. As the sources on which the author has drawn for his information are often far from accurate, it is unfortunately not possible to depend very much on the statistics based upon such questionable data.

The smaller defects in printing, &c., are not numerous, though it will be noticed, among other things, that Fig. 26 has been printed upside down.

Our chief cause of regret is that this book should have appeared as one of the volumes of Engler and Drude's series, "Die Vegetation der Erde," and that it should thereby receive a certain stamp of authority.

SIGNS AND SYMBOLS, EGYPTOLOGY, AND FREEMASONRY.

The Signs and Symbols of Primordial Man, being an Explanation of the Religious Doctrines from the Eschatology of the Ancient Egyptians. By Dr. Albert Churchward. Pp. xxiii+449. (London: Swan Sonnenschein and Co., Ltd., 1910.) Price 25*s*. net.

THIS is a book well worth reading, difficult to describe, and impossible to criticise. The title would lead one to expect a scientific analysis and classification of ancient signs and symbols, as well as a digest of the religious doctrines from the eschatology of the ancient Egyptians. The author in his own discursive way deals with an abundance of materials for a truly scientific work, but the best that can be said of the scientific character of the book is that, with ordinary care in dovetailing the materials and exact references to sources, it would have been a useful work of reference.

What makes criticism impossible is (1) the author's wholesale repudiation of all authorities and theories which cross his path, and (2) the fact that the book is dedicated to "All my brother Masons." The book covers a vast field outside Egypt, but almost every paragraph bears a stamp which may be interpreted: All was once Egyptian, now Masonic. With great erudition and ingenuity—and good-humoured pugnacity—facts and theories of all sorts are massed together in no particular order to form what must be charming reading for Freemasons. There is no lock which the author's key cannot open. There is no other authority on any of the subjects discussed to be allowed to bar the author's path. He knows and believes; 18°, 30°, and 33° also know and believe; and everybody else either does not or should not know. To deal with the author's exploits in the open field of scientific inquiry would be perfectly useless, because at any adverse turn of the argument some Masonic mystery would envelop both the author and the subject, and you would strike a "dead wall of mystery." Astronomy and orientation are discussed in a grandly dogmatic fashion, and most astounding statements are unaccompanied with anything like a scientific demonstration.

The title of the book will doubtless attract readers other than Masonic, and they will find, with a multitude of other statements of the same kind, the origin of the pre-Columbian Americans finally accounted for; Mexican crafts in the Mediterranean laden with Masonic treasures from Egypt; Egyptian priests invading Ireland and Britain; the Ainu of Japan in Egyptian universities; Pythagoras going about Egypt begging for crumbs of information withheld from him, but jealously guarded for the benefit of English and American Freemasons; and the North American Indians talking Welsh, an old story.

The following citations selected quite at random on adjoining pages illustrate the author's method. Referring to the epagomenal days of the Egyptian year, the author observes: "The first, third, and fifth of the epagomenal days were considered unlucky. In Freemasonry these numbers have a peculiar significance, which all M.M.'s understand, and with the common herd of people these days are still considered as unlucky days and numbers. How many know why or the origin of it?" (p. 14). How first-rate authorities are "herded" by our author is shown in his estimate of Dr. Eduard Seler's work, "that he has not succeeded in giving the true decipherment of any of his translations of the various codices of the Mayas, Mexican, and Central American nations that he has attempted to, and until he recognises Egypt as the primordial and origin we are of opinion that he will not" (p. 15). JOHN GRIFFITH.

PEDAGOGICS.

(1) *Education.* A First Book. By Prof. Edward L. Thorndike. Pp. ix+292. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 6*s.* net.

(2) *L'Education Physique ou l'Entraînement Complet par la Méthode Naturelle.* Exposé et Résultats. By Georges Hébert. Pp. iii+85+8 plates. (Paris: Librairie Vuibert, 1912.)

(1) IT need scarcely be said that any book on education by Prof. Thorndike will be suggestive and helpful; yet it is not quite easy to realise the constituency for which his latest work is specially written. If this first book is meant for students in training for the teaching profession, it seems to contain at once too little and too much. The volume is a simple introduction to the whole theory of education. Rather less than one-seventh of the book concerns the elementary practical situations which usually come into the control of the beginner. Experience shows that practice, unless it is begun before there is some power of reflection, furnishes the best starting point for the future teacher, and a first book for the trainee should therefore concern itself primarily with bringing out the fundamental features of the practical situation. Chapters on the meaning and value of education, the aims and results of education and the like appear so remote from the problem of the moment that students are apt to be impatient of them. A background of classroom experience would, however, give point and meaning to such discussions.

On the other hand, if the book is written for those who have already had teaching experience and come up for a fuller theoretical course, one would again have expected a different proportion in the various parts of the book. Indeed, the slightness of all the discussions almost puts this type of reader out of consideration. Prof. Thorndike has nevertheless written with his usual clearness and charm, and nobody who reads the book can fail to find some new illustration, some new way of putting an old point, or some suggestive phrase which he will treasure, and as to our general quarrel with it, we ought to add that probably no two authorities are agreed as to what is the best way of introducing the future teacher to the study of his profession.

(2) The English Board of Education has made up its mind about what is the best method of physical training for school children. All this is written down in an official book which every teacher in training must master. Such a proceeding on the part of the Board has its critics, who are not slow to say that there is no one and only system of physical training, and that more depends on the spirit in which the physical exercises are gone through than on the particular movements it embraces. "Teach your boys to walk, to run, to jump, to box, and to swim, and leave those artificial extension movements, which mean nothing, alone!" This is the spirit of M. Hébert's little book. It is not, of course, written in criticism of our Board of Education; it is just a simple account of the methods applied to the physical training of French sailors and of the results achieved. The author calls it the natural method, because his system is based on just those movements which men are called upon to make in the ordinary course of a life of freedom. Teachers and others who are concerned about physical training will find the work interesting and suggestive. It is abundantly illustrated.

J. A. G.

OUR BOOKSHELF.

The Significance of Ancient Religions. In relation to Human Evolution and Brain Development. By Dr. E. Noel Reichardt. Pp. xiv+456. (London: George Allen and Co., Ltd., 1912.) Price 12*s.* 6*d.* net.

THE nature of this work by Dr. Reichardt can be best indicated by a citation from the introduction: "And the practical value of the study of these religions lies in this, that not only does it acquaint us with the forces that have determined human history and built up human character; it affords us, moreover, the key to all the bewildering problems of modern psychology. For these religions tell us exactly what has taken place in the human brain during this period of development. The evolutionary process . . . has added to the human brain a new layer of cells; and it is the progressive development of this new layer of cells, carried on through each successive wavelet, that has given rise to the astounding phenomena of human history."

The reviewer, although familiar with recent research on the cortex of the brain, has failed to identify "the new layer of cells" mentioned by Dr. Reichardt. It appears from his text that these cells were at first "barred from contact with the outside world by the pre-existing mind organ," but in the Greeks it appears "the new mass of cells entered into relation with the outside world," giving "them that brilliant power of objective ideation which still glorifies them in our eyes." The author's explanation of the evolution of human religions and human faculties has the merit of simplicity and the unfortunate demerit of being founded on imagination rather than on ascertained facts.

Michael Heilprin and His Sons. A Biography. By Gustav Pollak. Pp. xvi + 540. (New York: Dodd, Mead and Co., 1912.) Price 3.50 dollars net.

MICHAEL HEILPRIN was in many ways a remarkable man. A Polish Jew, who, after a short residence in Hungary, betook himself to the United States, he exhibited an extraordinary faculty for accumulating information. The editor of his life states that he read eighteen languages and his memory was stored with tens of thousands of dates. In America he drifted into literary work and became a writer of articles in encyclopædias and journals and a frequent contributor to the *Nation*. Of his two sons, Louis, the elder, followed in the footsteps of his father, but Angelo was destined to achieve a wider fame.

Born in Hungary, Angelo Heilprin was taken to Philadelphia at the age of three years. He studied for a year in London at the Royal College of Science, and was much impressed by Huxley's personality and tuition. At first geology claimed his attention, especially invertebrate palæontology, but in later years he became a well-known traveller, visiting Mexico, the Arctic, British Guiana and Alaska. His greatest achievement in this line was his work in Martinique, where his daring ascent of Montagne Pelée within a few days after the great eruption of May, 1902, showed that in addition to his eminence as a scientific investigator he was a man of indomitable energy and dauntless courage. He died at the early age of fifty-four, having apparently overtaxed his strength by continual travel, writing and lecturing.

This biography scarcely does justice to its subject, as there is little biographical matter and the book consists mostly of long cuttings from articles in encyclopædias and journals. Angelo Heilprin had an attractive personality and a fine scientific record, of which we get only faint and distant glimpses in this story of his life.

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.]*

The Rise of Temperature Associated with the Melting of Icebergs.

IN a letter to NATURE published in the issue of December 1, 1910, I showed by means of microthermograms taken on a trip to Hudson's Straits that an iceberg melting in salt water produces a rise of temperature. The experiments were performed on the Canadian Government steamship *Stanley*, and indicated that when approaching ice a rise of temperature occurred followed by a rapid fall of temperature a quarter of a mile abeam of the berg.

During the past summer I had an opportunity of examining in detail the temperature effects of icebergs. The Canadian Government placed their steamship *Montcalm* at my disposal for the tests, and three weeks were spent through the Straits of Belle Isle. Careful records were made of the temperature effects of icebergs and land. These tests have shown conclusively that it is the rise of temperature which is the direct action of the melting iceberg, and that when a fall of temperature is observed near ice it is due to the influence of a colder current from the north in which the iceberg is carried. The cooling influence of the ice itself is very small. Cooler currents exist in the main Arctic current, whether accompanied by ice or not, but the presence of the ice causes a zone of water of higher temperature to accumulate for a considerable distance about it.

The icebergs I studied in the Straits of Belle Isle and off the eastern end of the Straits in the Labrador current showed no cooling effect even within a few yards of them.

In Fig. 1 I show the isothermal lines about a typical berg off the eastern end of the Straits of Belle Isle. This diagram was obtained by arranging a number of courses for the ship from all sides up to the ice along radii of six miles.

As a good example of how icebergs and groups of icebergs affect the water temperature, I show a microthermogram in Fig. 2 taken from the records which were obtained in a westward passage through the Straits of Belle Isle. In every case the approach to ice caused a rise of temperature.

The explanation of this iceberg effect which I gave at my Friday evening discourse at the Royal Institution last May was founded on Pettersson's theory of ice melting in salt water. By this theory, which can easily be verified by a simple experiment, ice melting in salt water produces three currents: (1) a current of sea water cooled by the ice, which sinks downward by gravity; (2) a current of warm sea water moving towards the ice; (3) a current of light fresh water from the ice, which rises and spreads over the surface of the salt water.

I at first thought that it was this surface current of fresh water that influenced the microthermometer in the actual sea tests. The fringe of this lighter water would be warmer than the sea water on account of the action of the sun and scattered radiation, which is very strong at sea. The lighter water would retain the heat because it could not mix readily with the sea water. Near the iceberg I considered that a fall of temperature would result from the cooling influence of the surface current of fresher water.

My recent tests have shown, however, that an iceberg melts so slowly that no effect of the dilution can be detected even right beside the berg. I took a number of samples of sea water at different distances from the berg, as well as from places far from ice. These samples I carefully bottled and brought home to the laboratory, where they were most accurately tested by the electric conductivity method in our physico-chemical department by Dr. McIntosh and Mr. Otto Maass. The tests were carried out at a constant temperature in the most favourable circumstances, and there is no reason to doubt their correctness. Their comparison shows no dilution due to the icebergs, which goes to show how quickly the melted water from the berg is mixed with the sea water. Larger variations were found over different parts of the sea than were obtained in the proximity of ice.

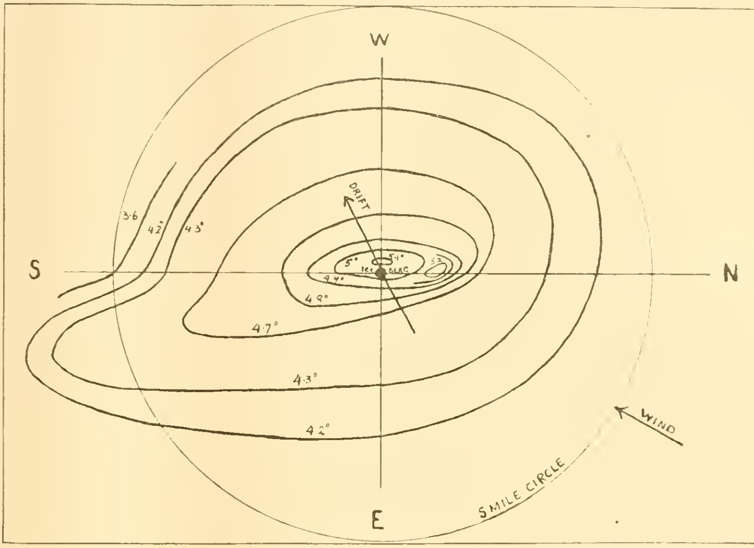


Fig. 1.—Isothermal lines around an iceberg.

Fig. 2.—Microthermogram through the Straits of Belle Isle, showing the rise of temperature caused by ice.

My tests have shown that an iceberg probably causes only two of the Pettersson currents, *i.e.* a cold current sinking downwards carrying with it all the melted ice water, and a horizontal surface current of sea water flowing in towards the ice to cause its melting (see Fig. 3). By this means we should expect the sea in the immediate proximity of icebergs to be warmer than further away, because the sea surface current is moving inwards towards the berg, and does not share in the normal vertical circulation which tends to keep the sea surface temperature cooler.

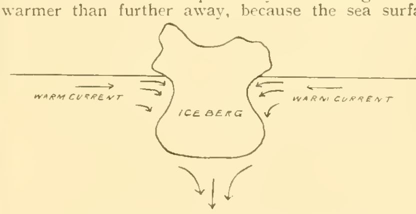


Fig. 3.—Convection currents due to iceberg melting. The fresh water from the melting berg is carried downwards.

It is interesting to find that an iceberg causes its own current of warmer water, thus providing for its own destruction. Abundant evidence is at hand to show the melting process going on under the waterline.

Dissolved Air.

In my observations of icebergs I was greatly struck with the large amount of dissolved air in the ice

The white colour of the berg is due to innumerable air bubbles in the ice, and not to snow on the surface. An iceberg is very deceptive in this way. While it looks quite soft, the ice is so hard as to make it difficult to chop with an axe. The ice water which I prepared for drinking on board ship with iceberg ice effervesced like soda-water, merely due to the liberation of the air from the melting ice. It is possible that the sudden disappearance of bergs with a loud report is due to their explosion from accumulated air in the interior. One berg which I studied was casting off small pieces, apparently by the pressure of the pent-up air.

Effect of Land.

While icebergs send the temperature of the sea up, the coast-line sends it down. I believe this to be due to the action of the land in turning up the colder under-water. My observations show this effect not only here, but on the English and Irish coasts.

From the point of view of the safety of our St. Lawrence route, the effect of land is most important. The iceberg causes us very little worry because we have only a very short ice track, but to find means whereby the presence of land can be determined is of the greatest importance. A full account of my experiments is being published by the Canadian Department of Marine.

H. T. BARNES.

McGill University, November 16.

The Bending of Long Electric Waves Round the Globe.

I HAVE just noticed (very belatedly) that in your reprint of Dr. Fleming's admirable opening of the British Association discussion of the problems of wireless telegraphy, there occurs a passage that raises an objection to a certain mathematical result of mine. Dr. Fleming's opinion in all matters radio-telegraphic is of such great weight that his objection, whether sound or not, is sure to prejudice the fair consideration of a hypothesis I have based on the mathematical result in question, and since the objection has obtained the wide publicity of your columns while my own account of the matter has not, I trust you will allow me space to comment upon it. Comment seems especially necessary on account of Dr. Fleming's eloquent advocacy of certain rival hypotheses.

Put briefly, the theorem is to the effect that the velocity of long electric waves through air containing charged ions is greater than the velocity through unionised air, and this leads to a hypothesis for explaining, among other things, the propagation of electric waves over the convexity of the globe. In forming the electromagnetic equations I took the average dielectric constant of the ionised air to be the same as that of the un-ionised air, following in this respect the example of previous writers on similar problems. It is to this customary assumption that Dr. Fleming's objection applies.

In rebutting the objection there are several plain courses. For example, I might recall that the formula I deduced for the increase of velocity may also be obtained from the accepted theory of "anomalous" dispersion—a theory in which the influence of a finite change of the dielectric constant is considered to be negligible. But in the present instance it seems preferable to take another course, and to ask, plainly, Why should the presence of electrified molecules in the number required by my hypothesis affect the dielectric coefficient used in the differential equations? It must be noticed that the concentration of the ions demanded for bending a ray to fit the curve of the earth is of the order 10^5 ions per c.c., assuming the ions to be molecular in size; and thus the proportion of ions to molecules is of the order 10^{-13}. It appears to me most unlikely that such a small proportion of ions can affect the real dielectric coefficient of the medium, especially in view of the fact that there does not seem to be any direct or indirect evidence based on experimental or theoretical knowledge of gases that can be held to support such a view.

I may add that I am quite well aware of many real difficulties confronting the hypothesis. I am not now writing in reference to any of those, but wish merely to point out that the objection urged by Dr. Fleming is, so far as I can see, a remotely conjectural one.

W. H. ECCLES.

University College, Gower Street, W.C.,
December 2.

The Specular Reflection of X-rays.

IT has been shown by Herr Laue and his colleagues that the diffraction patterns which they obtain with X-rays and crystals are naturally explained by assuming the existence of very short electromagnetic waves in the radiations from an X-ray bulb, the wave length of which is of the order 10^{-9} cm. The spots of the pattern represent interference maxima of waves diffracted by the regularly arranged atoms of the crystal. Now, if this is so, these waves ought to be regularly reflected by a surface which has a sufficiently good polish, the irregularities being small compared with the length 10^{-9} cm. Such surfaces are provided by the cleavage planes of a crystal, which represent an arrangement of the atoms of the crystal in parallel planes, and the amount by which the centres of atoms are displaced from their proper planes is presumably small compared with atomic dimensions.

In accordance with this, the spots in Laue's crystallographs can be shown to be due to partial reflection of the incident beam in sets of parallel planes in the crystal on which the atom centres may be arranged, the simplest of which are the actual cleavage planes of the crystal. This is merely another way of looking at the diffraction. This being so, it was suggested to me by Mr. C. T. R. Wilson that crystals with very distinct cleavage planes, such as mica, might possibly show strong specular reflection of the rays. On trying the experiment it was found that this was so. A narrow pencil of X-rays, obtained by means of a series of stops, was allowed to fall at an angle of incidence of 80° on a slip of mica about one millimetre thick mounted on thin aluminium. A photographic plate set behind the mica slip showed, when developed, a well-marked reflected spot, as well as one formed by the incident rays traversing the mica and aluminium.

Variation of the angle of incidence and of the distance of plate from mica left no doubt that the laws of reflection were obeyed. Only a few minutes' exposure to a small X-ray bulb sufficed to show the effect, whereas Friedrich and Knipping found it necessary to give an exposure of many hours to the plate, using a large water-cooled bulb, in order to obtain the transmitted interference pattern. By bending the mica into an arc, the reflected rays can be brought to a line focus.

In all cases the photographic plate was shielded by a double envelope of black paper, and in one case with aluminium one millimetre thick. This last cut off the reflected rays considerably. Slips of mica one-tenth of a millimetre thick give as strong a reflection as an infinite thickness, yet the effect is almost certainly not a surface one. Experiments are being made to find the critical thickness of mica at which the reflecting power begins to diminish as thinner plates are used. The reflection is much stronger as glancing incidence is approached.

W. L. BRAGG.

The Cavendish Laboratory, Cambridge,
December 8.

The Investigation of Flint.

The need for a more accurate knowledge of the dynamics of flint, as pointed out by Sir E. Ray Lankester in Nature of November 21, is very obvious.

Though not so remarkable as the Savernake polished flints, yet some are to be found in the shingle for some miles both east and west of Brighton. Flints, too, with even more glaze than either of these are met with on the arable land of this district. These I assume got at some time the benefit of the vegetable ash resulting from the burning of weeds, being raked up along with them. Originally they came in the chalk from the North Downs for the use of the crops.

A caution may be useful as to what may be expected as the result of frost action. I have watched many of our Wealden sandstones for about twenty years, chiefly because of my study of the honeycomb weathering. One wall I guess at least 100 yards long, on the west side of Mount Pleasant Hill, has soil behind it nearly to the top. It shows good dusty weathering along a line about 2 ft. from the pavement at the junction of the second and third courses of stone. There are, however, two very distinct patches, each two or three yards wide, where this is entirely absent. Why is this? Merely, I believe, because the places happen to get extra rain-water from two adjoining trees, and are never dry all the winter. Parts, however, which are wet and dry alternately frequently suffer.

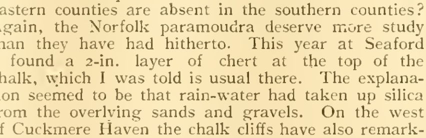
Why, I wonder, is it that the small mammilations seen on the squared flints of the churches in the eastern counties are absent in the southern counties? Again, the Norfolk paramoudra deserve more study than they have had hitherto. This year at Seaford I found a 2-in. layer of chert at the top of the chalk, which I was told is usual there. The explanation seemed to be that rain-water had taken up silica from the overlying sands and gravels. On the west of Cuckmere Haven the chalk cliffs have also remarkable rings of chert, sometimes 6 in. thick, surrounding each of the numerous pipes seen in the chalk there. These chert cylinders can be seen lying on the shore owing to the erosion by the sea. For a long time these were great puzzles, but their explanation was discovered last year by my friend, Mr. Hy. Preston, of Grantham.

George Abbott.

Tunbridge Wells, November 23.

Remarkable Formation of Ice on a Small Pond.

Some soil (which is of a heavy nature), being required, had been dug out to a depth of about a foot. The sides and bottom were thus quite irregular. Rain-water lodged in the hole, thus forming the pond, which was about 4 ft. long, 1 ft. 6 in. wide, and 5 in. maximum depth; the major axis was N.E. and S.W.,



and the upper surface of the ice about 8 in. below the general level of the ground.

The ice was first noticed at 0.30 p.m. on Sunday, December 1. Dark sinuous lines about ⅜ in. wide and running about parallel to the major axis were plainly visible. These were seen to be due to the water below touching the ice along these lines, while the bands (about 2½ in. wide) of white between the lines were due to the water not being in contact with the ice at these portions of the under-surface. The water in the pond had gradually percolated away, and had thus left an air space of about ⅛ in. between itself and the under-surface of the ice between the dark lines. On breaking the ice and getting a piece out, it was found to have the remarkable cross section shown in the sketch. The ice was quite clean and clear, and the dovetail ribs were well off the bottom of the pond. The ribs were remarkably regular in form and dimensions, and there were about six lines of them running from end to end of the pond.

There was no wind, and the frost on the grass near by was crisp, indicating that the temperature was still below 32° F.

A. S. E. Ackermann.

Anthropology at the British Association.

I notice in the article on anthropology at the British Association in Nature of November 21 a slight misstatement, which I should be obliged if you would correct.

The coloured photographs which I showed to the section were taken partly by my friend Mr. Mellor and myself, and the scenes represent different tombs which I excavated in 1903–05.

Robert Mond.

Combe Bank, near Sevenoaks, November 25.

ATMOSPHERIC ELECTRICITY.

During the last few years a large number of experiments and observations have been made which, instead of solving the central problem of atmospheric electricity, appear to have made it more difficult than ever. It seems desirable, therefore, that a short statement of the present position should be placed before the large body of physicists who have not yet considered this exceedingly interesting subject.

Measurements of the electrical conditions of the atmosphere have now been made over the land from north polar regions through the equator to south polar regions, over the centres of the Atlantic and South Indian Oceans, and on Samoa in the Pacific Ocean. Thus the conditions over both land and ocean areas have been investigated, and everywhere it has been found that the air is a conductor and that the potential gradient is practically the same. The result can be expressed in rather a more objective way by stating that the earth has been found to be a negatively charged sphere, of a nearly uniform surface density, surrounded by a conducting atmosphere. This, however, cannot be a complete statement of the case, for by the laws of electrostatics a charge cannot exist within a conductor, and in consequence the charge on the surface of the earth must be transferred more or less quickly to the outside of the conducting atmosphere. In spite of this, the charge on the earth's surface remains undiminished. Whence, then, comes the negative charge to make this possible? This is the chief problem of atmospheric electricity.

To make it clear that the surface of the earth does lose electricity, it will be as well to state the methods used to determine the loss. The surface of the earth is at a uniform potential, which for convenience is called zero. If, therefore, a certain area of this is insulated, it can only remain at the potential of the remainder so long as it receives or loses no charge. If it was losing a charge before it was insulated, it can only be kept at zero potential after insulating by supplying it with the charge lost. In 1906 C. T. R. Wilson designed an instrument by means of which an insulated plate could be kept at zero potential while exposed to the atmosphere, and the charge which had to be supplied to do this could be measured. The result proved an actual loss of negative electricity. The amount of this loss was found to be equal to that which can be calculated from a knowledge of the potential gradient and the conductivity of the air.

Realising that the plate in Wilson's instrument did not exactly represent a piece of the ground and that measurements at odd times could always be objected to, a method was developed in Simla by which a continuous record could be obtained of the charge necessary to keep at zero potential a large area—17 square metres—which was to all intents and purposes a part of the surface of the ground. This instrument was in use for nearly a month, and registered a continuous loss of negative electricity. These experiments indicate clearly that during fine weather negative electricity actually passes from the earth into the air. This disposes of the possibility of the lost charge being renewed uniformly over the whole earth by such processes as the fall of charged dust, friction of the air on the earth's surface, or the absorption of ions from the air. The loss over the whole earth is equivalent to a constant current of more than 1000 amperes. As this loss takes place from all regions of the earth, subject to normal or fine weather conditions, it would appear that the return current can only exist in regions of disturbed weather, and it is known that in such regions the potential gradient is often reversed and the rain charged.

A reversed field certainly causes a flow of negative electricity into the earth, but as the time during which the field is reversed in any one place is only a very small fraction of the time during which it is normal, the flow of electricity would have to be enormous if the loss were made good in this way. Such a large flow could not possibly escape detection, and no one has seriously put forward this as a solution of the problem.

There is still the possibility that the electricity comes to the earth in the disturbed area as a negative charge on the rain. For many years this was the most favoured theory for the supply of the negative electricity, but in 1908–9 measurements were made in Simla which showed that there, at least, the rain carried down more positive than negative electricity. Since then many measurements have been made on the electricity of rain, and now we have before us the results of observations made in Porto Rico, Simla, Vienna, Potsdam, Puy-en-Velay and Dublin. In every one of these cases the Simla result is confirmed, and there can be no doubt now that in all kinds of rain, from the intense rain of thunderstorms to the drizzle of a depression, more positive than negative electricity is brought to the earth. Thus rain, instead of solving our problem, has made it more difficult.

It has been suggested that the charge may be returned in the lightning of thunderstorms. Prof. Schuster has discussed this point in his recent book, "The Progress of Physics" (p. 150), and comes to the conclusion: "It does not seem to me, judging by present information, that lightning discharges from cloud to earth can play an important part in increasing or diminishing the charge of the earth," and there are other reasons, not mentioned by Prof. Schuster, for coming to the same conclusion.

We have now discussed the conditions in disturbed areas and have not found the return current, for neither the reversed field, the precipitation, nor the lightning provides it. Thus the science of atmospheric electricity has come to a deadlock, and there is at present no indications of a way out.[1] We may sum up the position in the following statement. A flow of negative electricity takes place from the surface of the whole globe into the atmosphere above it, and this necessitates a return current of more than 1000 amperes; yet not the slightest indication of any such current has so far been found, and no satisfactory explanation for its absence has been given.

GEORGE C. SIMPSON.

PROF. FRIEDMANN'S TREATMENT OF TUBERCULOSIS.

THE announcement of the successful application of any new method of treating tuberculosis must always arouse intense interest and create new hope among those who are suffering from, or waging war against, this disease. For the latest of these, devised by Prof. Friedmann, of Berlin, it appears to be claimed that it acts not only curatively in cases where tuberculosis has already commenced, but prophylactically where there exists a danger of infection to those not already tuberculous. A large number of cases have been treated in Berlin and Vienna, and it is said that where the disease is not far advanced it is cut short, and that in children as yet unaffected the tissues and organs have been protected against the invading tubercle bacillus. This therapeutic agent appears to be some form or preparation of a non-virulent tubercle bacillus or some bacillus nearly allied which has been deprived of its toxic constituents or products.

In view of the outcome of the experiments made by the Royal Commission on Tuberculosis on the immunisation of animals by the use of injections of living tubercle bacilli, it is almost to be desired that the vaccine is of the nature of a prepared proteid and does not contain any living bacilli, however modified. Judging from the accounts we

[1] Prof. Ebert has proposed an explanation, but against it fatal objections have been raised. Those interested might consult the series of articles which appeared in the *Physikalische Zeitschrift* between March, 1904, and December, 1905.

have seen of the method, it can scarcely be a modification of the "immune body" treatment, with which, it is maintained, some success has been attained. It appears more likely that we have to deal with some modification of Calmette and Guerin's method, in which the bovine tubercle bacillus is cultivated on a glycerinated medium to which a small proportion of ox-bile has been added. Here, after about forty generations of such culture, the bacillus becomes so far modified that when injected intravenously into the bovine animal it is incapable of setting up an active tuberculous process, and so modifies the tissues and especially the wall of the alimentary canal of the treated animal that an ordinary culture of a virulent "bovine" bacillus is no longer able to retain its position in the tissues of the host, and, consequently, is unable to set up any tuberculous process.

It is, of course, too early to pronounce any definite opinion, either favourable or adverse, on these various methods. It must be realised that a certain proportion of the cases in which there is tuberculous infection recover without any special treatment; that others recover when supplied with plenty of fresh air, good food, and when the hygienic conditions generally are favourable, and that these agencies are called into play by all who are engaged in the intelligent study and treatment of tuberculosis.

SIR GEORGE HOWARD DARWIN, K.C.B., F.R.S.

GEORGE DARWIN, whose decease occurred at Cambridge on Saturday, December 7, came, as is well known, of illustrious scientific lineage, having been born in 1845 at Down, the second son of Charles Darwin, author of "The Origin of Species," and thereby the renovator of the biological sciences. Like many contemporaries who attained to distinction in scientific pursuits, his school education was gained under the Rev. Charles Pritchard, F.R.S., afterwards Savilian professor of astronomy at Oxford. He went up to Trinity College, Cambridge, in 1864, graduated as second wrangler and second Smith's prizeman in 1868, the present Lord Moulton being senior; he was elected a fellow of Trinity the same year, and enjoyed the statutory tenure of ten years. In addition to mathematical subjects, he was interested in economic and political science, and with a view to practical life was called to the Bar in 1874. About this time he wrote a well-known statistical memoir on the marriage of first cousins, an early example of the present exact investigations in cognate biological domains. Considerations of health, however, prompted his return to Cambridge, where he devoted himself to mathematical science, especially in its astronomical aspects. He had already initiated his most striking contributions to the subject of the evolution of the solar system, especially the moon-earth system, and to cosmogony in general, when he was elected to the Plumian chair of astronomy and experimental philosophy in 1883. He was re-elected fellow of Trinity, as professor, in 1884, and his marriage dates from the same year.

If one were asked to name a domain in which the power of mathematical analysis had conspicuously asserted itself over phenomena apparently most complex and fortuitous, the prediction of the tides up to their closest details, by procedure now systematised so that it can be applied almost without technical skill, would surely come to mind. The principles of the application of harmonic analysis to this subject were laid down by Laplace, following up the beginnings established long before by Newton; but it was a far cry from this to actual systematic performance. The outstanding name in this magnificent achievement is that of Lord Kelvin, whose intellectual energy kept the subject to the fore, while his inventive genius originated the machines by which calculations too long and laborious for arithmetical processes were reeled off automatically. But it is very doubtful whether tidal practice, in which British methods dominate the world, or the refinements of tidal theory, would stand in their present completeness if Kelvin had not enjoyed the good fortune, when he was himself getting submerged in other problems, of finding a colleague so imbued with the subject, so expert and tenacious amid the complexities of numerical calculation, as George Darwin proved himself to be. His tribute to Lord Kelvin, to whom he dedicated volume i. of his Collected Scientific Papers, which relates to this subject, gave lively pleasure to his master and colleague:—

> Early in my scientific career it was my good fortune to be brought into close personal relationship with Lord Kelvin. Many visits to Glasgow and to Largs have brought me to look up to him as my master, and I cannot find words to express how much I owe to his friendship and to his inspiration.

The practical developments of tidal theory and prediction were published to the world in a series of reports to the British Association, worked out mainly by Darwin, from the year 1883 onward. In 1879 he had broken ground in another direction, entirely fresh. The recognition of lunar tidal friction as a cause of lengthening of the day goes back to Kant. The problem as to how the tidal loss of energy is divided between the earth's rotation and the lunar orbit had baffled Airy; it had been shown by Purser that the principles of energy and momentum conjointly can lead to its solution; but it remained for Darwin to develop, by aid of graphical representations which have become classical, most striking inferences regarding the remote past history of our satellite. This discovery was the starting point of a series of memoirs in the next subsequent years, which applied similar procedure to the precession of the equinoxes and to other features of the solar system.

In the later years of last century, during Lord Kelvin's meteoric visits to Cambridge to attend the annual meetings of the Fellows of Peterhouse, and to absorb whatever of scientific interest was going on, he was certain to find his way to Newnham Grange, to compare impressions on tidal and cosmical theory and to concert plans for future action. So thoroughly was Darwin from the first immersed in and a partner of Kelvin's work on these subjects, that the necessary rewriting, for the second edition, of the large section of Thomson and Tait's "Natural Philosophy" which deals with tides and their cosmical relations, was confided entirely to his hands.

In 1898 he supplemented this work by publishing a non-mathematical treatise on the tides and kindred phenomena in the solar system, which was developed from a course of Lowell lectures delivered at Boston, and has taken rank with the semi-popular writings of Helmholtz and Kelvin as a model of what is possible in the exposition of a scientific subject; it has accordingly been translated into many foreign languages. The preparation of a new edition of this book, expanded and in part rewritten to include recent developments, was one of the last works of his life.

His studies in astronomical evolution necessarily required him to push the history of the motions of the planetary bodies back into the past, far beyond the times for which the usual practical approximations of gravitational astronomy are suitable or valid. To this end he began to apply a process of step-by-step plotting to the determination of orbits in the classical problem of three bodies,—essayed in simpler cases by Lord Kelvin, but in its adequate use laborious, and demanding skill in arrangement of arithmetical processes; this work culminated in an extensive memoir in "Acta Mathematica" in 1896. The maps of families of orbits there published attracted the attention of other mathematicians. In particular, Poincaré—utilising the general mode of discrimination and classification which he had already employed with signal success in Lord Kelvin's and George Darwin's problem of the forms possible for fluid rotating planets—pointed out the necessary existence of some intermediate classes that had escaped the analysis. And S. S. Hough, H.M. Astronomer at the Cape, who had in his Cambridge days collaborated with Darwin in tidal theory, followed with a memoir devoted to fuller developments. This fascinating subject continued to occupy Darwin's attention up to the end of his life; one of his last public appearances in London was to communicate a paper on it to the Royal Astronomical Society.

His thorough familiarity with the methods of reducing to mathematical order the tangled data of tidal observation marked out Darwin as a desirable expert guide in the national meteorological service; for much was hoped for meteorology thirty years ago from the practical application of harmonic analysis to the voluminous records of barometer and thermometer. Accordingly the Royal Society, which then had control of the service, nominated him a member of the Meteorological Council soon after his return to Cambridge. When that Council was rearranged as a Committee under the Treasury a few years ago, he became one of the two representatives whom the Royal Society was requested to nominate to the new body; and he continued to render valuable service in this capacity until the end.

The earliest of topographic surveys, the model which other national surveys adopted and improved upon, was the Ordnance Survey of the United Kingdom. But the great trigonometrical survey of India, started nearly a century ago, and steadily carried on since that time by officers of the Royal Engineers, is still the most important contribution to the science of the figure of the earth, though the vast geodetic operations in the United States are now following it closely. The gravitational and other complexities incident on surveying among the great mountain masses of the Himalayas early demanded the highest mathematical assistance. The problems originally attacked in India by Archdeacon Pratt were afterwards virtually taken over by the Royal Society, and its secretary, Sir George Stokes, of Cambridge, became from 1864 onwards the adviser and referee of the survey as regards its scientific enterprises. On the retirement of Sir George Stokes, this position fell very largely to Sir George Darwin, whose relations with the India Office on this and other affairs remained close, and very highly appreciated, throughout the rest of his life.

The results of the Indian survey have been of the highest importance for the general science of geodesy, and well-deserved tributes have been paid to them by Helmert, of Berlin, and other chief exponents of the science. It came to be felt that closer cooperation between different countries was essential to practical progress and to coordination of the work of overlapping surveys. Accordingly, about fifteen years ago the International Geodetic Association was established, through scientific and diplomatic influences, to take cognisance of all problems of refined surveys and triangulations, and other investigations relating to the form of the earth, in which international cooperation is essential to complete results. Sir George Darwin was appointed by the Foreign Office, on the advice of the Royal Society, as the British representative on this important international body; and its work was henceforth one of the main interests of his life. It came to the turn of England to receive the triennial assembly in the year 1909, and a very successful meeting at London and Cambridge was organised mainly by his care. He was preparing to go to the meeting of the association in Hamburg last September when his fatal illness supervened.

An important public service has been rendered in this country for many years by the Cambridge University Press, through the application of its resources to the publication in definitive collected form of the works of the great men of science whom this nation has produced, thereby sustaining the national credit in a way which in other countries is promoted mainly by Government subsidy. The collected papers of Sir George Stokes, Arthur Cayley, James Clerk Maxwell, Lord Kelvin, J. J. Sylvester, J. C. Adams, P. G. Tait, J. Hopkinson, and other men of science have in this way been garnered, and have taken their permanent place among the national possessions. It came as a great gratification to George Darwin when, in 1907, the syndics of the University Press signified to him their desire to become responsible for a collected edition of his scientific memoirs, to be prepared under his own supervision. In May, 1911, the last of the four substantial royal octavo volumes in which his work is thus arranged for future generations was published.

In the affairs of the University of which he was an ornament, Sir George Darwin made a substantial mark, though it cannot be said that he possessed the patience in discussion that is sometimes a necessary condition to taking share in its administration. But his wide acquaintance and friendships among the statesmen and men of affairs of the time, dating often from undergraduate days, gave him openings for usefulness on a wider plane. Thus at a time when residents were bewailing even more than usual the inadequacy of the resources of the University for the great expansion which the scientific progess of the age demanded, it was largely on his initiative that, by a departure from all precedent, an unofficial body was constituted in 1899 under the name of the Cambridge University Association, to promote the further endowment of the University by interesting its graduates throughout the Empire in its progress and its more pressing needs. This important body, which was organised under the strong lead of the late Duke of Devonshire, then Chancellor, comprises as active members most of the public men who owe allegiance to Cambridge, and has already by its interest and help powerfully stimulated the expansion of the University into new fields of national work; though it has not yet achieved financial support on anything like the scale to which American seats of learning are accustomed. Another important body in the foundation and development of which Sir George Darwin took an active part is the Cambridge Appointments Board, which, by bringing trained graduates into connection with the leaders of the commerce and industry of the nation, has worked with notable success for their mutual advantage.

Sir George Darwin's last public appearance was as president of the fifth International Congress of Mathematicians, which met at Cambridge on August 22–28 of this year. The time for England to receive the congress having obviously arrived, a movement was initiated at Cambridge, with the concurrence of Oxford mathematicians, to send an invitation to the fourth congress held at Rome in 1908. The proposal was cordially accepted, and Sir George Darwin, as *doyen* of the mathematical school at Cambridge, became chairman of the organising committee, and was subsequently elected by the congress to be their president. Though obviously unwell during part of the meeting, he managed to discharge the delicate duties of the chair with conspicuous success, and guided with great *verve* the deliberations of the final assembly of what turned out to be a most successful meeting of that important body. But this improvement was only temporary; on their return to Cambridge a month later his friends were most deeply grieved to find that, after some weeks of illness, an exploring operation had strengthened the fears of malignant disease which had not been absent from his own mind for some time.

In the previous year there had come to him what he naturally regarded as the crowning honour of a life devoted to scientific pursuits, the award by the Royal Society in October, 1911, of their highest distinction, the Copley medal for the year. He had himself strongly advocated the claims of his kinsman, Sir Francis Galton, who was the medallist of the preceding year, unconscious that his own name had been standing on the list for consideration. Galton died within a year of the award, and his life, written by Darwin for the Dictionary of National Biography, appeared last October. The Royal Society has thus the melancholy satisfaction of having been just in time in two successive years in conferring her highest mark of distinction on the achievements of two of her distinguished sons. J. L.

MR. S. A. SAUNDER.

It is with deep regret that we have to record the death, on Sunday night, December 8, of Mr. S. A. Saunder, at sixty years of age. In Mr. Saunder astronomical science has lost a devoted and conscientious worker who gave himself whole-heartedly to a line of study requiring much ability, and involving immense labour, but offering no prospect of startling results.

Mr. Saunder was an assistant master at Wellington College. He became a Fellow of the Royal Astronomical Society in 1894, and from 1907 to February last he was one of the most active and hard-working of honorary secretaries. A few years ago he was appointed Gresham Professor of Astronomy in the City of London. He gave his last course of lectures (on the tides and tidal friction) early in November, but the fatal illness was then upon him, and it was with great difficulty and pain that he brought the lectures to a conclusion.

Mr. Saunder's scientific work lay especially in the domain of selenography, in which he achieved well-deserved distinction. His paper in the Monthly Notices of the Royal Astronomical Society for January, 1900, on the determination of selenographic positions and the measurement of lunar photographs, was the first of a series of similar papers. In the fourth paper of the series he gave a first attempt to determine the figure of the moon. In the Memoirs of the R.A.S., vol. 59, he published the results of measures of four negatives taken at Paris by Loewy and Puiseaux, with a catalogue of 1433 measured points on the lunar surface. All the positions were carefully reduced to mean libration, and their places given in rectangular co-ordinates. A still more extensive work was published in the R.A.S. Memoirs, vol. 60: Results of measures of two Yerkes negatives by Mr. G. W. Ritchey. The catalogue contains

2885 points, all carefully reduced by Prof. Turner's method, and forming a very valuable contribution to our knowledge of the lunar surface.

One object in view in the preparation of these extensive catalogues of lunar details was that they should be the foundation of a standard chart of the moon. Mr. Saunder had carefully studied the subject of lunar nomenclature, and was much impressed with its unsatisfactory state. He proposed that in future new names should be added very sparingly, but that objects observed should be referred to by their coordinates in the catalogue or in the chart. Charts of all the central portions of the moon, entirely based on Mr. Saunder's measures, which he plotted for the purpose, are now in progress and approaching completion.

NOTES.

AT the recent annual meeting of the Royal Geological Society of Cornwall the Bolitho gold medal was awarded by the president and council to Mr. Geo. Barrow, for his services to Cornish geology in connection with the re-survey of the west of England.

AT the suggestion of Prof. Ernst Cohen, the Dutch sculptor, Pier Pander (Rome), has executed a beautiful bronze medallion of van't Hoff. We are requested to state that anyone desiring to purchase a copy of it should send (before January 1, 1913) a postcard to Prof. Ernst Cohen, van't Hoff Laboratorium, University, Utrecht, Holland. The medallion will then be sent by the firm entrusted with the work. If 100 copies are sold the price will be 6.50 marks. The price will be reduced to 5.50 marks if 200 copies can be sold. The medallion has been executed after a portrait relief in marble by Pier Pander.

THE Tokyo *Asahi* announces the forthcoming formation in Japan of a society for the prevention of tuberculosis. The initiators are Dr. Baron Takagi, Dr. Baron Sato, and Dr. Kitasato. The preliminary meeting was held on October 29, when an influential committee was appointed to make the necessary arrangements. Good work has been done in the campaign against tuberculosis by minor local organisations in Japan, but the formation of the new society is the first serious public attempt to grapple with the disease. It is stated that, although no precise statistics are available, the number of persons who fall victims to tuberculosis in Japan may be estimated at no fewer than a million per annum. As the population of the country is about fifty-one million, this would indicate an annual death-rate of nearly twenty per thousand from the disease.

MAJOR E. H. HILLS, C.M.G., F.R.S., treasurer of the Royal Astronomical Society, has been appointed honorary director of the Observatory, University of Durham.

THE next meeting of the American Association for the Advancement of Science will be held in Cleveland from December 30 next to January 4, 1913. Prof. E. C. Pickering will be the new president. The address by the retiring president, Prof. Charles E. Bessey, on some of the next steps in botanical science, will be delivered on December 30. The sections among which the business of the meeting will be distributed, with the name of the retiring president of the section and the subject of his address, are as follows:—Mathematics and Astronomy, "The Spectroscopic Determination of Stellar Velocities," Prof. Frost; Physics, "Unitary Theories in Physics," Prof. R. A. Millikan; Chemistry, "The Chemistry of the Soil," Prof. Cameron; Geology and Geography, "Significance of the Pleistocene Molluscs," Prof. Shimek; Zoology, "Section F—Is it Worth While?" Prof. Nachtrieb; Botany, "The Scope of State Natural Surveys," Prof. Newcombe; Anthropology and Psychology, "The Study of Man," Prof. Ladd; Social and Economic Science, "Comparative Measurements of the Changing Cost of Living," Prof. Norton; Education, "Educational Diagnosis," Prof. Thorndike; Physiology and Experimental Medicine, "The Function of Individual Cells in Nerve Centres," Prof. Porter. During the days of the meeting twenty-six American scientific societies will also meet.

THE Melbourne meeting of the Australasian Association for the Advancement of Science will be held on January 7–14 next. The president-elect is Prof. T. W. E. David, C.M.G., F.R.S., and the retiring president Prof. Orme Masson, F.R.S. The meeting will be held at the University, which is surrounded by large grounds, and can provide ample accommodation. Prof. Baldwin Spencer, C.M.G., F.R.S., who is spending the year as chief protector of aborigines in the Northern Territory, will deliver a lecture on some of the results he has obtained. A joint discussion of several sections will be held on the genus Eucalyptus and its products. A forest league is being formed in the various States, under the auspices of the association, which it is hoped will rouse public opinion to the necessity of preserving forests, especially round the head waters of the rivers. A large number of committees will present reports, and a full programme of papers is expected. The following are the presidents of sections:—Astronomy, Mathematics, and Physics, Prof. H. Carslaw; Chemistry, Prof. C. Fawsitt; Subsection Pharmacy, Mr. E. F. Church; Geology and Mineralogy, Mr. W. Howchin; Biology, Prof. H. B. Kirk; Geography and History, Hon. Thos. M'Kenzie; Ethnology and Anthropology, Dr. W. Ramsay-Smith; Social and Statistical Science, Mr. R. M. Johnston; Agriculture, Mr. F. B. Guthrie; Subsection Veterinary Science, Prof. Douglas Stewart, Engineering and Architecture, Col. W. L. Vernon; Sanitary Science and Hygiene, Dr. T. H. A. Valintine; Mental Science and Education, Sir J. Winthrop Hackett. The general secretary for the meeting is Dr. T. S. Hall.

SPEAKING at the annual dinner of the Farmers' Club on Tuesday, Mr. Runciman, president of the Board of Agriculture and Fisheries, referred to the assistance which the Development Commissioners propose to give to agricultural research. In the course of his remarks, he said:—It was not enough merely to adopt a policy of slaughter, scheduling areas, and so forth. They should adopt so far as possible all the services that science could supply. They must give their research institutions, universities, and colleges the needful to ascertain more and more the nature of their most dangerous diseases. He had received permission only that day to announce that one of the schemes he had been enjoining for some months in the country had so far met with the approval of the Development Commissioners that they would shortly recommend to the Treasury a release from the Development Fund of moneys for the following objects: First of all to provide in every one of what were now called the provinces, for the purposes of agricultural education, the services at the headquarters of those provinces of men concerned with advice as to soils, crops, and so forth, but who should be concerned also with live stock; that each one of these men should be an organiser or supervisor, to organise in that province a live stock scheme which would be described in further detail. The Commissioners were also prepared to enable them, with an annual sum, to have engaged in their office a man of the highest class, who could not know everything about every branch of live stock, but, by general knowledge, would be able to give administrators advice which at present they were without. Thirdly, premiums would be provided from the Development Fund for the breeding of heavy horses, Shires, Clydesdales, and Suffolk Punches.

The annual general meeting of the Royal Agricultural Hall, Islington, was held yesterday, December 11, when the report of the council was presented. The total number of governors and members of the society during the year has been 10,307, as compared with 10,306 in the previous year. About the same number of samples were submitted for analysis by the chemical department of the society as during the preceding twelve months, this being 426. Special reference is made in the reports to Bombay cotton cake containing excessive sand, rice meal composed mainly of rice "shudes" (husks), barley meal adulterated with pea husks, and sharps adulterated with pea husks and containing an excessive amount of sand. Among much other important work done at the Woburn Experimental Farm may be mentioned an interesting series of experiments on varieties of lucerne and on methods of sowing this crop which was carried forward, the best results coming from Russian (Europe) lucerne, and then from Canadian and Provence seed. The plots sown on bare ground were uniformly better than those laid down in a barley crop. There were also trials with different varieties of wheat—including French wheats—and of barley. Progress has been made during the year with the experiments which are being carried out at Woburn for the purpose of demonstrating that by means of isolation it is possible to rear healthy stock from tuberculous parents. It is hoped that the final report on the experiments will be ready some time next year. The council decided last year to offer the society's gold medal annually for original research in agriculture. Five essays have been submitted by qualified candidates.

With reference to the letters in Nature of November 14 and December 5 concerning the moon and poisonous fish, a correspondent writes from Doncaster to say that twenty-five years ago he heard many stories from sailors of the ill-effects caused by eating fish which had been exposed to moonlight. He adds:—"The probabilities are that the same belief was held by the sailors in the early days of emigration to South Africa, and transmitted to the colonists."

Mr. W. F. Denning believes that the shaking of windows and similar effects experienced at Sunninghill and the neighbourhood on November 19, as mentioned in Nature of November 28, p. 365, had their origin in meteoritic explosions. In the course of a letter published in *The Westminster Gazette* of December 9, he says:—"I have investigated several instances of similar kind, and the conclusion has been irresistible that they were induced by fireballs undergoing disintegration high in the atmosphere. And in the recent case this explanation is rendered highly probable from the fact that the period from November 19 to 23 is well known astronomically for its abundance of detonating fireballs. Messrs. Greg and Herschel attributed a special significance to the period named, and their deductions have been fully corroborated by later experiences."

A copy has been received of the fifth annual report (1911–12) presented by the council to the court of governors of the National Museum of Wales. It contains an account of the ceremonies in connection with the laying of the foundation-stone of the new building by the King on June 26 last, and much information as to the progress made during the year. The Treasury has agreed to an estimate of 233,000*l.* for the erection and furnishing of the new building. The financial position at present is as follows:—Local contributions, 42,000*l.*; an equal amount from the Treasury, 42,000*l.*; making the total sum available at present 84,000*l.* This leaves a deficiency of 149,000*l.*, one-half of which will be found by the Government, provided a like amount is forthcoming from other sources. The Treasury has increased its grant towards maintenance for the year 1912–13 to 3000*l.*, as compared with 2000*l.* in the past. The Cardiff Corporation has erected a building and has leased it to the museum for a period of five years from July 1 last, at a rental of 130*l.* per annum, for the purposes of a temporary museum. Expenditure to the amount of 567*l.* has been incurred in the purchase of specimens during the year, and an appendix of eight pages is devoted to a list of donations of specimens to the museum.

A summary of the weather during the recent autumn has been issued by the Meteorological Office as comprised by the results for the period of thirteen weeks ended November 30. The mean temperature for the whole period was below the average over the entire kingdom, the greatest deficiency being 2° in the south-east of England; the deficiency was also considerable in the south-west of England and in the Channel Islands. The autumn rainfall was below the average everywhere except in the east of Scotland, where the excess amounted to 0·83 in. The duration of bright sunshine was below the average over the entire kingdom. At the close of autumn the temperature of the soil at the depth of one foot was very generally above the normal, and it was also generally high at the depth of 4 ft. The mean temperature of the sea for the closing week was mostly above the average, and was, in general, warmer than in the corresponding period of last year. For the neighbourhood of London the Greenwich observations show that the mean temperature for the autumn was 48·6°, which is 2·1° below the normal; the mean for September was 4·4° below the average, and in October the deficiency was 2·2°, whilst in November there was an excess of 0·3°. The highest shade temperature during the autumn was 69° and the lowest 29°, the latter observed in both October and November. In September there were only four days with the temperature in excess of the average. The aggregate autumn rainfall was 5·49 in., and the rainfall was deficient in each of the three months, being in the aggregate 1·73 in. less than the normal. In all rain fell on thirty-five days. The duration of bright sunshine was 265 hours, which is two hours in excess of the average for the last thirty years.

THE October number of *The National Geographic Magazine* is devoted to China, and contains, as usual, a splendid collection of illustrations. Canal life is described by Mr. F. H. King, and Lhasa, "the most extraordinary city in the world," by Dr. Shaoching H. Chuan. Of special interest is the article on China's Treasures, by Mr. F. McCormick, in which he deals with the famous Rock Temples. Of these the most remarkable are the series of Buddhist shrines at Lung Men, in the province of Honan, where the sides of a gorge have been excavated and the walls of the caves ornamented with thousands of figures. The district of Shensi contains the colossus of Buddha, 56 ft. high. The buried monumental remains throughout the country are of enormous extent. Of these little has been examined, but their importance is illustrated by the remarkable bricks recently found at Peking, and the bells 2000 years old unearthed at Kiangsi, and now said to be in the Forbidden City.

To *The Field* of November 23 Mr. Pocock contributes an important summary of statements as to the obliterative effect of the colouring of zebras, the earliest of these being by Sir Francis Galton (1853). It is pointed out that the passages quoted indicate that independent observers have noticed the obliterative nature of the colouring in five distinct members of the group, and it is urged that the same credence must be assigned to these statements as to those of observers who take an opposite view.

EVIDENCE is gradually accumulating that the South American family Iniidæ, now represented by the fresh-water dolphins of the genera Inia and Pontoporia (to retain a well-known name), was abundant in America during Tertiary times. The latest addition to the list is the new genus and species, *Hesperocetus californicus*, established by Prof. True (Smithson. Misc. Collect., vol. lx., No. 11) on the evidence of an imperfect lower jaw, with teeth, from the Californian Tertiaries. The genus, which is provisionally referred to the Iniidæ, is remarkable for the length of the symphysis of the lower jaw and the large size of the teeth, which recall those of the extinct Delphinodon, classed by the author with the Delphinidæ. Other extinct Iniidæ are Saurodelphis, Pontoplanodes, and Ischyrorhynchus.

THE Codling moth (*Carpocapsa pomonella*) has lately been the subject of much careful research in the United States. In his admirable memoir on the insect published in 1903 (U.S. Dept. Agric., Bull. Entom., No. 41) Mr. C. B. Simpson referred doubtfully to the possible occurrence of a third brood of the insect in certain American localities. We have now received A. G. Hammar's "Life-history Studies on the Codling Moth in Michigan" (*ibid.*, No. 115., part 1, 1912). Statistical studies of the generations during the three years 1909, 1910, and 1911 are illustrated by many elaborate tables and curves, derived from observations at various localities in the State. It appears that some of the caterpillars hatched in the spring of one year hibernate and pupate the next spring, as in the usual life-cycle of the insect in our islands. Others pupate in summer, and from the pupæ some moths emerge quickly to lay the eggs of the second brood, while others do not emerge until the next spring. Most of the caterpillars of the second brood hibernate, but a few pupate in autumn, and from a small proportion of these pupæ moths emerge, to become the parents of a third brood of larvæ, all of which must hibernate. Thus it follows that "The wintering larvæ may include larvæ of the first, second, and third broods. The spring brood of pupæ may include pupæ of the first, second, and third broods. The spring brood of moths may include moths of the first, second, and third broods"—a somewhat surprising result.

DR. F. TOBLER has published an important monograph of the genus Hedera ("Die Gattung Hedera," Gustav Fischer, Jena, price 6.50 marks). The author describes two new species of ivy (*Hedera himalaica* and *H. japonica*), making six species in all, which are well illustrated by reproductions from photographs. Besides detailed descriptions of the morphology of the genus, the work includes an interesting chapter on the biology and physiology of the ivy, followed by chapters on the history of the genus and its culture as a garden plant; it is to be wished, however, that for the sake of completeness, the author had dealt with the comparative anatomy of the genus—apart from the characteristic star-shaped hairs of the ivy leaf, no microscopic descriptions or figures are given.

FROM Dr. C. J. Chamberlain, of Chicago University, we have received reprints of two recent papers on the Cycadaceæ, continuing his previous studies on this important group of plants, and, like them, published in *The Botanical Gazette*. In a paper on the adult cycad trunk, the author describes the structure of the mature stem in species of Zamia, Dioön, and Ceratozamia, and with excellent material at his disposal has considerably supplemented the descriptions of earlier writers. The two species of Dioön studied show growth zones which may or may not correspond to the periods of activity resulting in the formation of the crowns of leaves; one of the species shows a remarkable resemblance in details of stem structure to the

Cretaceous fossil genus Cycadeoidea, a member of the extinct family Bennettitales, which was in some respects more primitive than the cycads, and formed a link between this group and the Pteridospermæ, or fern-like seed-plants. In a second paper the author describes the development and fertilisation of *Ceratozamia mexicana*, and notes the curious fact that the normally small and evanescent ventral canal nucleus may enlarge and approach the egg, possibly fertilising it.

WE have received from Messrs. Flatters and Garnett, Ltd., 32 Dover Street, Manchester, a copy of their lantern slide catalogue "E," together with specimen slides illustrating a large range of subjects (biology, geology, astronomy, textile fibres and machinery, scenery, &c.). The slides submitted for inspection are remarkably fine reproductions from photographs, and the prices appear very reasonable. Of the series of slides listed in this very comprehensive catalogue, those dealing with botanical subjects are the most complete, and these include an extensive set of slides illustrative of plant associations at home and abroad. The list of slides in the section of British plant associations is arranged in accordance with the plan adopted in the recently published standard work on British ecology—"Types of British Vegetation," edited by Mr. A. G. Tansley—and may be warmly commended to teachers and lecturers as the best and most complete set of ecological slides available. One of the most remarkable series of slides offered is that consisting of no fewer than 130 photomicrographs illustrating the development of *Pinus sylvestris*.

ALTHOUGH few details of scientific value have been made known about the disastrous Turkish earthquake of August 9 last, Dr. G. Agamennone has been able to draw some conclusions of interest. The shock, which in places attained the intensity 10 of the Rossi-Forel scale, was strong enough to damage buildings over an area nearly 200 miles long and 125 miles wide, and containing about 20,000 square miles. The epicentre cannot yet be located with accuracy, but it must have been near the north-west coast of the Sea of Marmora. As more than 3000 persons were killed, the earthquake must rank as one of the most destructive European shocks of the last thirty years.

THE curious phenomenon known in Japan as *Inada no goko*, or halo in the ricefield, forms the subject of a discussion by Profs. Fuchino and Izu, of the College of Agriculture and Forestry, Kagoshima, in the Journal of the Meteorological Society of Japan (October, 1912). In the early morning, when the dew lies on the plants, and the sun is shining, the shadow of the head of a person standing in the fields is surrounded by a luminous halo, elliptic in form, its long axis corresponding with that of the body-shadow. As the sun rises higher in the sky and the dew evaporates the halo vanishes, but reappears on sprinkling the ground with water. The authors describe some experiments which they carried out with blankets, isolated drops of water, and bottles. They conclude from their experiments that the phenomenon of the halo is caused by the reflected light from the sun-images formed on the green blades by the passage of the sun's rays obliquely through the dewdrops.

ESTIMATES of the age of the earth based on the ratio of the amounts of helium and uranium present in the Carboniferous and older rocks have given results of the order 400 to 1500 million years. Estimates based on the quantity of sodium brought into the oceans by the rivers of the world and the amount in the ocean at the present time lead to 70 million years. A possible explanation of this discrepancy is offered by Dr. F. C. Brown, of the University of Ithaca, in the October number of *Le Radium*. He suggests that sodium is itself a radio-active element with a parent which is insoluble in water. The sodium of the soil would then be due to the decomposition of the parent, and that of the ocean to the solution of the sodium in the soil and its transport by rivers. During the earliest periods the soil content being small, the transport to the ocean would be reduced, and the age calculated from the present content of the ocean would be correspondingly increased.

THE Journal of the Washington Academy of Sciences for November 19 contains an abstract of a paper on the atomic weight of bromine by Mr. H. C. P. Weber, of the Bureau of Standards, which is about to be published in the bulletin of the Bureau. The method adopted is that of Noyes and Weber, by the direct synthesis of hydrobromic acid, and it was found capable of giving results of high accuracy. The final value obtained on the basis of oxygen 16, hydrogen 1·00779, is 79·924, as against the International Commission value 79·920.

TWO papers on agriculture are included in the October issue of *Science Progress*. Dr. J. V. Eyre gives an interesting account of Russian agriculture, in which he presents a picture of a vast territory, of which only a small part is under cultivation; moreover, on account of the poverty and indolence of the peasants the agriculture is of a very low order, artificial manures and agricultural machinery being almost unknown over vast areas of the country. The writer suggests that a few good harvests would probably do more than anything else to enable the impoverished farmers to carry out the improvements in method with which many of them are already familiar as a result of the active work of instruction undertaken by the Government. Dr. Spencer Pickering contributes the first of a series of papers on horticultural research, in which he describes the Woburn experiments on the planting of trees. These experiments have suggested that rough treatment in planting is often more effective than the careful handling of root fibres, which is usually recognised as correct. Both articles are illustrated by several pages of photographs.

THE 1913 issue of "The Scientists' Reference Book and Diary," published by Messrs. James Woolley, Sons, and Co., Ltd., dealers in scientific apparatus, chemical reagents, &c., of Manchester, has all the useful characters of the issues of previous years. The student of science will find it very convenient to have together in the same compact pocket-book a small work of reference containing important constants and facts, and also a diary arranged by Messrs. Charles Letts and Co. The price, bound in leather with gilt edges, is 2s.

MESSRS. J. AND A. CHURCHILL announce for early publication "A History of Chemistry, from the Earliest Times till the Present Day," by the late Dr. J. Campbell Brown; "Notes on Chemical Research: an Account of Certain Conditions which Apply to Original Investigation," by Mr. W. P. Dreaper; "A Text-book of Anatomy for Nurses," by Dr. Elizabeth Bundy; and "Who's Who in Science (International), 1913," edited by Mr. H. H. Stephenson.

OUR ASTRONOMICAL COLUMN.

THE ANNULAR SOLAR ECLIPSE OF APRIL 17.—Those interested in the phenomena of the annular eclipse which took place in April last will find forty-eight columns of records and discussion in No. 4615 of the *Astronomische Nachrichten*. Herr Ladislav Beneš describes the observations of contact times, &c., made at the Strassburg Observatory, and, after discussing them, arrives at corrections for the places of the sun and moon; the central line deduced lies between the lines given by the *Connaissance des Temps* and the *Bureau des Longitudes*, rather nearer to the latter.

The observations made at the Leipzig Observatory are described by several observers, and Herr F. Hayn gives a set of curves showing the measured irregularities of the moon's limb. Prof. Luther brings together a very large number of observations made at various stations in the Rhine province, and derives a central line passing through $\lambda = 6° \ 45' \ 40{\cdot}35''$ E., $\phi = +51° \ 25{\cdot}6'$, giving a correction of $-0{\cdot}4'$ in latitude to the central line published by Prof. Battermann. He also gives a good photograph taken by Herr P. Bohnen. Prof. Wilkens publishes the results of the Kiel observations, giving the true sun and moon positions for the moment of each observation, and finds the corrections published in the American ephemeris were very near the truth.

An interesting paper by Drs. Elster and Geitel, dealing with the sun's observed light-curve during the eclipse, appears in the *Physikalische Zeitschrift*, pp. 852–855.

A REMARKABLE SHOWER OF METEORIC STONES.—In No. 203, vol. xxxiv., of *The American Journal of Science*, Mr. W. M. Foote gives a preliminary account of the shower of meteoric stones which occurred near Holbrook, Navajo County, Arizona, on July 19. Mr. Foote has collected a large mass of evidence which appears to settle the question of authenticity favourably. A large meteor was seen to pass over Holbrook at 6.30 p.m. on the date mentioned, and created a loud noise, which lasted for half a minute or more. Numerous stones were seen to fall near Aztec, raising puffs of dust for over a mile of the sandy desert, and subsequently a great number of these stones were found by the local people; the largest found weighed more than 14 lb., while several of about 5 lb. each were picked up over an elliptical area about three miles long and half a mile broad. The preliminary physical and chemical tests point to an undoubted meteoric origin, and a sample taken from twelve individual stones was found to contain 3·68 per cent. of nickel-iron, with 96·32 per cent. of silica. The principal constituent appears to be enstatite, olivine and monoclinic pyroxene making up the balance; in one section a patch of spinels set in quartz was found. Altogether more than 14,000 stones, weighing, in all, more than 481 lb., were picked up and preserved, but of these 8000 weighed less than one gram each; 29 stones had weights ranging from 6665 grams to 1020 grams, and some 6000 ranged between 1000 grams and one gram.

THE ORBIT OF COMET 1910*a*.—In No. 4605 of the *Astronomische Nachrichten* M. S. Mello e Simas publishes definitive elements of the orbit of the bright comet 1910*a*. The author has discussed an enormous number of observations, and sets out in full detail the numerous points he has taken into consideration, finally arriving at the conclusion that the orbit is a parabola with an inclination of $138° \ 46' \ 55{\cdot}78''$, the time of perihelion being 1910, January 17·09464 (M.T. Paris). He also discusses the question of the multiple solutions of problems of cometary orbits, which so confused a number of calculators in endeavouring to find a satisfactory orbit for comet 1910*a* during the time of its apparition.

THE "GAZETTE ASTRONOMIQUE."—It is with pleasure that we learn that the *Gazette Astronomique*, published by the Antwerp Astronomical Society, is again to appear each month. The gazette fulfils a very useful purpose in publishing monthly ephemerides and notes for observers, and, also, in popularising astronomical subjects.

THE NEW PHARMACOLOGICAL LABORATORY AT UNIVERSITY COLLEGE, LONDON.

WHEN University College was incorporated in the University of London, a scheme was formed to replace the old laboratories of the medical sciences by more adequate institutes in the south quadrangle. The first part of the plan was completed in 1909, when the Physiological Institute was opened. A second instalment has been rendered possible by a donation of 5000*l*. by Mr. Carnegie, and the Pharmacological Institute was opened on Wednesday, December 4, by Sir Thomas Barlow, president of the College of Physicians. It is to be hoped that the third institute, for Anatomy and Anthropology, may follow in due course and complete the buildings for the medical sciences.

The new pharmacological laboratory has been built from the plans of Prof. F. M. Simpson, of University College, and occupies an area of 42 ft. by 50 ft. immediately adjoining the physiological building on the east. It contains three complete floors and a mezzanine floor, besides the basement, the actual floor space amounting to about 6000 sq. ft., besides the stairway and passages. The building is lighted on three sides by large windows, which occupy the maximum amount of space permissible under the Building Acts. The ground floor is lined with white glazed brick throughout, and contains a reading-room 24 ft. by 18 ft., and the pharmacological-chemical laboratory, 24 ft. by 30 ft., fitted with two large chemical benches and fume cupboards. It communicates with an open-air balcony on the south side, which is arranged for investigations on noxious gases. On this floor there are also a balance-room, a dark-room, and an attendant's workshop. Between the ground and first floors a mezzanine floor contains lavatories and a hospital-room for animals under observation. The animal houses proper lie behind the building.

The first floor contains private rooms for professor and assistant, and two large experimental rooms, 24 ft. by 18 ft. and 24 ft. by 30 ft. respectively. The smaller of these is designed for work with the large kymograph, while the larger is used for smaller movable apparatus. A heavy beam runs through both rooms at a height of $8\frac{1}{2}$ ft. from the floor, and serves to support shafting and pulleys, which are set in motion by an electric motor in the larger room. Gas and water pipes also run along this beam, which carries, in addition, wires from an electric clock, and a tube supplying artificial respiration, so that these are all available throughout the laboratory. A floor channel running beneath the beam carries off waste water, and, in addition to wall switches, a number of floor plugs are inserted in its neighbourhood to supply light and power where necessary. This laboratory is fitted up with the ordinary experimental apparatus, and with a small centrifuge and incubator for hæmolysis work.

The second floor contains a small preparation and drug room for use in the lectures and demonstrations and the large lecture-room laboratory. This measures 48 ft. by 25 ft., and is fitted up with lecture desk, blackboards, and projection lantern, and with practical room benches for elementary work in pharmacology. A recess off the lecture-room, 18 ft. by 13 ft., is furnished with three tiers of standing places rising one above another, from which the spectators look down directly on the experimental table below. The students are expected to perform the simpler experiments in the laboratory, and these will be discussed and elucidated from the lecture table. The more complicated experiments will be done by the demonstrator on the special table in the recess, and when these are in progress the students will leave their places in the body of the laboratory and stand round and above the demonstration table. In this way it is hoped to be able to correlate the lecture, the practical work, and the demonstrations more closely than is possible when these are all given in different courses and in different rooms.

New Pharmacological Laboratory, University College, London.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

THE presidential address was delivered by Prof. H. L. Callendar at 10 a.m. on Thursday, September 5. This was published in full in NATURE of September 5 (p. 19).

Wireless Telegraphy.

The principal discussion arranged was a joint one with Section G on the scientific theory and outstanding problems of wireless telegraphy; it was opened by Prof. J. A. Fleming. Dr. Fleming had drawn up a list of twenty-four questions to which definite answers are still required. In the short time available to him it was impossible to go seriatim through these. After outlining the general methods of signalling now employed, he pointed out that the chief question was how such waves, if they are true Hertzian waves, are propagated a quarter of the way round the earth. The mathematical investigations of Prof. MacDonald, Lord Rayleigh, the late Prof. H. Poincaré, and of Dr. Nicholson seem to have proved that diffraction alone will not account for the phenomenon, even though the waves as used by Marconi have a wave length of nearly four miles. Prof. Sommerfeld had come to the conclusion that there must be "surface waves" at the boundary of the earth and atmosphere, and that these vary in amplitude inversely as the square root of the distance, and are sufficiently feebly damped in a horizontal direction to be propagated long distances, irrespective of irregularities of surface. Another theory has been based by Dr. Eccles upon the ionisation of the atmosphere. If the velocity increases with the ionisation, the upper part of a wave may travel faster than that near the surface, and the direction of propagation will be deflected downwards.

Closely connected with this is the inhibiting effect of daylight. Absorption due to ionisation is not sufficient. Refraction owing to varying dielectric constant arising from ionisation may be operative here. Many other problems require elucidation, such as the greatly reduced signalling distance at dawn and dusk, the inequality in north-south and east-west transmission, the theory of directive antennæ, and the location of the direction of the arriving waves.

In the discussion Dr. W. Eccles directed attention to his paper read before the Royal Society in June last. In order to account for the great difference between day and night transmission it seems necessary to suppose that there exists in the upper atmosphere a permanently ionised layer that is not dependent on solar radiation for its maintenance—a suggestion due to Heaviside. This, in conjunction with refraction due to a gradient of ionisation, enables many phenomena to be explained without appealing either to diffraction or to absorption in the air or by the earth's surface.

Prof. A. E. Kennelly (of Harvard University) pointed out that partially quantitative observations on the effect of sunrise and sunset on signals received near Boston from the Marconi station at Glace Bay, N.S., indicated that an influence on received signals was projected ahead of the sunrise at the sending station. The effects might be partially explained if the ionisation of sunlight in the upper atmosphere produced a wall or nearly vertical series of ionised strata at the boundary of the daylight illumination with absorption in those strata and some irregular reflection from their faces.

Lord Rayleigh thought that there would always be many difficulties so long as we considered the earth a perfect conductor and the air a dielectric. Some seemed to suppose that the following of a wave round the earth was a consequence of the normality of the wave to the surface. That this is not so can be seen at once by realising that the same condition holds in the case of a sound wave.

The Sommerfeld theory was probably mathematically right, but a lot of time would be required to form an opinion as to its applicability to the problem. Sommerfeld came to the conclusion that it is the imperfection in the conductivity of the earth which facilitates transmission. This is certainly not in accordance with the first ideas we would come to. He approved of the lines of Dr. Eccles's investigation, especially in connection with the day and night complications. He was specially interested in the difference found to be necessary between the sending and receiving antennæ. This seemed to be in contradiction to the well-known principle of reciprocity. The explanation may be that for the validity of this principle all the effects must be linear. It is worth while to consider this difference between the two ends.

Prof. Macdonald and Dr. Nicholson both emphasised the certainty of results calculated on the pure diffraction theory, and the insufficiency of that theory, and expressed approval of investigations on the lines which Dr. Eccles took. Dr. Nicholson considered Prof. Sommerfeld's work to be rigorous so far as it went, but it was not certain that the investigation for a flat interface would apply to the earth. A very small area on the earth's surface would correspond to a very large area on a plane if one solution were mathematically transformed into the other.

Prof. A. G. Webster emphasised the importance of the lack of homogeneity of the earth and air. Captain Sankey seemed to despair of recording instruments, because they record everything. Prof. S. P. Thompson directed renewed attention to the pioneer work of Sir Oliver Lodge in 1894. Mr. S. G. Brown mentioned some experiments of his own in 1899. Contributions to the discussion were also made by Prof. Howe, Major Squire, and Prof. F. Baily. In a communicated contribution to the discussion, Prof. A. Sommerfeld emphasised the importance of the surface-waves. He thought that the difference between the day and night effect was due either to the increase of the conductivity of the air or to the upward bending action supposed by Dr. Fleming. He thought that one could not at the same time consider the ionisation a satisfactory explanation of the bending of the waves round the earth in long-distance transmission.

One important outcome of the discussion is that a committee of the Association has been formed to deal with radio-telegraphic investigations. The committee is without any specific instructions, but its first inquiry will probably be as to what concerted action is possible between investigators on this important subject.

General Physics.

Prof. S. P. Thompson gave a simple demonstration of the varying depth of the extraordinary image formed by a cleave of unaxial crystal. A block of Iceland spar was rotated so that the entrance and exit faces remained in fixed planes. Of the two images of a small electric light seen through this block, the ordinary image remains fixed; the extraordinary revolves round it in a tortuous curve.

Lord Rayleigh described some iridescent effects produced by a surface film on glass. These were specially brilliant when the glass was immersed in water, owing to equalisation of the amount of light reflected from the two surfaces. With regard to methods of cleaning, Prof. Webster inquired whether he had tried the well-known use of a gelatine film for removing all traces of dirt.

Prof. E. G. Coker described experiments on the flow of mercury in small steel tubes, especially at high velocities, at which the flow may be turbulent. The lowest velocity at which turbulent motion may commence is found to vary inversely as the diameter of the pipe and directly as the viscosity.

Dr. J. Gray gave several exhibitions of some spinning tops, many of them of new design, which appeared very useful for exhibiting gyrostatic properties.

Prof. W. Peddie described an apparatus for investigating the motion in torsional oscillations when viscous and hysteretic effects are present. The apparatus enabled a determination to be made of the connection between displacement and time throughout the motion. The author discussed the theoretical character of the results obtained.

Dr. S. R. Milner read an interesting paper on the current-potential curves of the oscillating spark. Two induction coils connected in series were actuated by the same mercury break; one of these charged a Leyden jar battery and produced the spark, the other simultaneously discharged through a vacuum tube giving kathode rays which were deviated in two directions at right angles by the magnetic field of the spark current and the electric field of the spark potential-difference. Photographs of the resultant curves due to single sparks were shown.

Dr. W. F. G. Swann described experiments indicating that the conductivity of paraffin wax increases with the field when values up to 100,000 volts per centimetre are employed.

Prof. W. G. Duffield and Mr. G. E. Collis exhibited photographs of a deposit upon the poles of an iron arc burning in air. The deposit, which is of a feathery nature, appears to be an oxide of iron. These growths vary from a millimetre to a centimetre in length; they increase in size by the condensation of metallic vapour or the vapour of an oxide of iron.

A paper by Dr. G. E. Gibson on a new method of determining vapour densities was taken as read in the absence of the author. The quartz manometer employed consists of a bulb of less than 1 c.c. capacity blown on a quartz tube 3 mm. in diameter, and flattened at one end so as to form a flexible membrane 1/10 mm. thick. The interior of this membrane is filled with the vapour under investigation, while the exterior is enclosed in a quartz chamber which communicates with a mercury manometer. A distortion of the membrane caused by a difference in pressure between the interior and the exterior causes a small quartz plate, which is polished so as to act as a mirror, to undergo a rotation about an axis in the plane of the polished surface.

Dr. T. M. Lowry described some very accurate determinations of the optical rotatory power of quartz, in which particular attention was paid to the purity of the quartz, and to obtaining light pure enough to give a clean extinction when reading a rotation of several thousand degrees, and of sufficient intensity to be read with a small half-shadow angle.

Prof. R. A. Sampson, in giving a short account of a paper on the calculation of the fields of telescopic object glasses, remarked that the object of long-focus lenses was not to diminish the effects of chromatic aberration, but to do so for the other types of aberration.

Prof. D. C. Miller showed a very ingenious and successful instrument for analysing sound vibrations. The membrane set vibrating by the source of sound tilts a mirror mounted on an axle. The essential feature of the instrument is the extreme minuteness of the mirror, which, together with the axle on which it is mounted, does not weigh more than two milligrams. The light received from the mirror is received by a second mirror continuously rotating round a perpendicular axis. Vibration curves were projected on to a screen, the amplitude being about two feet, and the length shown some twenty feet. The constitution of compound notes was thus instantly demonstrated, and in particular the constitution of vowel sounds.

In the report of the committee on electrical standards evidence is given of the satisfactory character of the methods which have been established, in a great measure by this committee, for the measurement of electrical quantities. The committee rightly considers that the primary objects for which it was appointed have been achieved. It has, however, been reappointed for another year in order to complete the business arrangements connected with the republication of the entire set of its reports from 1861 until the present time.

In a report of the committee to aid in the work of establishing a solar observatory in Australia, it is reported that the Commonwealth Government appointed a board to inquire and report upon the best site for an observatory within the federal territory at Yass-Canberra. They unanimously selected a site on the summit of a hill some 2500 feet above sea-level, and the Government has instructed Mr. Baracchi to establish a temporary observatory at the selected site, and to determine definitely whether it answers the requirements of modern scientific research, including astrophysics. The telescope is the gift of Mr. James Oddie, of Balarat, who offered it, together with other instruments, for this specific purpose. A 6-inch Grubb refractor, the gift of the trustees of the estate of the late Lord Farnham, is also to be forwarded to Australia. In view of the action now being taken by the Commonwealth Government, there can be no doubt of its intentions in the matter of solar work.

Atomic Heat of Solids.

The second formal discussion which had been arranged was on the atomic heat of solids. This was opened by Dr. F. A. Lindemann, of Berlin. If the ordinary principles of mechanics are admitted as governing the movements of atoms, equipartition of energy is bound to be attained, and the atomic heat of a solid at constant volume should be exactly 3R. To escape from Rayleigh's formula for the distribution of energy in the spectrum, Planck has assumed that an oscillator may only emit definite discontinuous quantums of energy, and shows that their magnitude is proportional to the frequency; and he develops the formula—

$$E = \frac{2c^2h}{\lambda^5} \frac{1}{e^{\frac{h\nu}{KT}} - 1},$$

where h is a new universal constant $6{\cdot}55 \times 10^{-27}$ erg. sec., $K = R/N$, and ν is the frequency. This formula appears to agree with experimental results. From this, on certain assumptions, Einstein has shown that the atomic heat of N atoms should be—

$$C_v = \frac{a^2e^a}{(e^a - 1)^2}, \text{ where } a = (h\nu)/(KT).$$

This formula is only approximately correct, and fails altogether if one inserts the true frequencies calculated from the reststrahlen, from the compressibility, density and atomic weight, or from the melting point, density and atomic weight. Nernst and Lindemann have empirically modified this formula by adding a second term in which a has half the value in the first, thus corresponding to frequencies an octave below those in the first term. This formula holds accurately for the atomic heat of the metals, diamond, NaCl, KCl, NaBr, and KBr, using the values of ν given by the reststrahlen.

It follows that the free electrons, if there are any, can only have a very small specific heat, for the atomic heats of conductors and non-conductors may be represented by practically identical curves. Further, it can be shown that "Nernst's theorem" is a consequence of the fact that the atomic heats are infinitely small at the absolute zero.

In the discussion, Dr. G. E. Gibson sketched an hypothesis by means of which the difficulty of Planck's assumption of a discontinuous absorption and emission of energy might be removed. He supposes that the discontinuity is confined solely to the collisions between the molecules with which the resonators are connected, so that during the time between collisions the resonators are subject to the ordinary laws of thermodynamics.

Lord Rayleigh was glad that, though the law of equipartition led to his own equation, this had not been so presented as to make it appear that he believed it to apply to all wave lengths. He considered that the difficulty attending the five degrees of freedom of a diatomic gas had not yet been removed satisfactorily. However stiff the molecule is made axially there is still a degree of freedom connected with axial separation of the two atoms. He was extremely interested in the quantum theory; the success it had obtained showed that it should not be given up, although at the same time it seemed to be throwing away most of our dynamical ideas. It implies the extraordinary result that when two molecules meet they may not take up motion because it is too small to be taken up at all!

Dr. J. W. Nicholson laid emphasis on the discrepancy between Lindemann's conclusion that the atomic heat of electricity is very small and the usual conclusion from the electronic theory of metals which requires a value for it so large as to be inadmissible. He felt very much in accord with the ideas put forward by Dr. Gibson.

Prof. Rutherford said that one point appealed to him. Foreigners seem to be content without realising a practical model or mechanism of the processes they assumed to take place. He did not lay great stress on the agreement between the theory and experiment—a double exponential equation can be fitted to almost anything. He was inclined to doubt whether the formula of Nernst and Lindemann was of the right form.

Prof. Bragg emphasised the corpuscular nature of other things, *e.g.* of X-rays. A number of other speakers also took part.

Dr. Lindemann, in his reply, pointed out that Pier and Bjerrum have shown that the molecular heat of the diatomic gases rises above the value $5R/2$ at high temperatures, and may be represented by the formula $5R/2+Rf(\nu,T)$, where $f($ is the same formula as that used for solids. The frequency (ν) coincides with the absorption bands in the case of some of the gases with charged ions (HCl, H_2O, NH_3, &c.). The fact that the molecular heat of hydrogen falls as low as $3R/2$ at the temperature of liquid air is far more difficult to explain even on the assumption of quanta, for the rotation takes place without potential energy in this case, and one would naturally expect the frequency to vary with the temperature, which would lead to a much more gradual diminution of the molecular heat than is actually the case. Personally he was doubtful of the validity of Poincaré's proof that one must assume a discontinuity to obtain Planck's formula. He considered it premature to construct a model; it is necessary first to find the conditions which a model must fulfil.

The most difficult fact to account for is the large conductivity for heat of crystals at low temperatures where the energy fall may be very small. Models which are based upon electrons being ejected are of no use, as they do not explain why an uncharged diamond atom does not start vibrating when struck by an uncharged helium atom. The agreement between calculation and experiment can scarcely be regarded as fortuitous, for there are no arbitrary constants in the formulæ. He did not think that the theory of free electrons in metals can be retained in its present shape. The calculation of Wiedemann-Franz's constant is based on the assumption that the free electrons have the mean kinetic energy of a monatomic gas at the same temperature. Planck's radiation formula would seem to lead to about one-third of this value, but this would make the thermal conductivity three times too small. It is noteworthy that the electric resistance appears to be very nearly proportional to the energy content, becoming independent of the temperature at low temperatures. The electric conductivity of very pure quicksilver is 100,000 times greater at the temperature of liquid helium than it is at 0° C.

If one assumes the number of free electrons to be very small, but to contain the energy of a monatomic gas, the electrical conductivity shows that the mean free path must be very large, and one comes into conflict with optical measurements, more particularly with those of Hagen and Rubens. He would be very loathe to accept the theory of corpuscular radiation. All arguments in its favour are valid also for light. The phenomena of interference show that a quantum of light might be 500,000 wave lengths or 25 cm. long. What would become of it if it were cut in two? He believes that Planck's second hypothesis of continuous absorption and discontinuous emission is able to account for the chief difficulty, viz. that a comparatively fast electron may be emitted under the influence of comparatively weak radiation.

Spectroscopy.

A third discussion was opened by Dr. J. W. Nicholson on series in spectra. The opener gave a general account of the work which has been done in the representation of spectra by formulæ, and followed with a review of the attempts made to obtain these formulæ from model atoms. He concluded that the Ritz formula cannot represent the actual facts, and that Hicks's modification and Whittaker's formula are difficult to interpret physically. A modern theory apparently must build up the atom from electrons and positive electricity—the latter, from work on radioactivity alone, being densely concentrated at the centre of the atom. The electrons must be arranged in rings to avoid excessive radiation (Schott), and the atom is Saturnian. The necessary permanence of structure can be secured by allowing expansion of electrons, or by a quantum theory, which is preferable. It has been shown that it is possible to explain the coronal and nebular spectra by simple ring systems with a quantum theory which implies a definite change of energy when an electron enters or leaves an atom. The spectra of such elements do not exhibit the usual series, but a series in which the cube-roots of the wave lengths differ by a constant amount. This is in accordance with a radiation of energy in discrete amounts proportional to the frequency. The difficulty in explaining Balmer's series is that in dynamical systems it is the square of the frequency, not the frequency itself, which is a rational function of integers. This difficulty is absent from the model of Ritz; but it is more probable that the origin of spectral series is kinematical (as Rayleigh has suggested) rather than dynamical. A process was sketched by which a series of lines

$$\lambda=\lambda_0\frac{n^2}{n^2-a^2}\ (a=\text{const.})$$

can be obtained for an atom with two rings of electrons by simple kinematical principles. If the outer ring contains only one electron the lines are doublets. The infinite number of lines is due to the infinite number of degrees of freedom of the æther.

In the discussion, Prof. Kayser said that the first thing is to get a theory—none are quite right. Ritz's is approximately right, but it cannot be the true one, because it leads to too large a number of components in the Zeeman effect. Hicks lays too much value on the accuracy of the measured wave lengths. We cannot hope to get the true wave length to one-thousandth Angström unit. For example, some lines in the iron spectrum are variable, being different at the positive and negative poles. Their character depends upon the conditions—Fabry obtains interference effects with them, while he himself cannot. In mixtures some calcium lines have a different wave length from those of the pure substance.

Prof. Fowler added the name of Halm to those whose formulæ required recognition. With regard to accuracy, half a tenth-metre error could arise from nebulosity; this can, however, be reduced by altering the conditions.

Prof. Peddie suggested the investigation of a more complicated system consisting of a succession of shells of alternate positive and negative character. He pointed out that if you make the atom rotate you must also take into account the magnetic forces.

Lord Rayleigh said that one point that was usually omitted was the difference between the vibration in the atom and that received by the observer. He instanced the case, in sound, of a revolving vibrating cylinder. The observer receives maxima and minima as the cylinder revolves—that is, there are two vibrations giving rise to beats.

Dr. Duffield discussed the pressure effect as a means for the resolution of a spectrum into series. Photographs were exhibited showing the different behaviour of spectral lines under pressure, thus facilitating their grouping. Prof. Kayser said he doubted if it is a pressure effect. Dr. King had found that in the electric furnace he gets a double amount, which shows that other conditions enter into account. He did not think it possible so far to determine series by this method, though certain groups are obtained. Just the same applies to the Zeeman effect.

After the discussion, Dr. Duffield also showed photographs of the arc spectrum of nickel under pressure. The effects resemble those obtained with the iron arc.

Dr. T. M. Lowry explained how he had calibrated a wave-length spectroscope in the infra-red region by aid of the fringes from a lightly-silvered etalon, using a thermopile and galvanometer instead of an eyepiece. Between $\lambda 8000$ and $\lambda 17,000$ the error was not more than 20 to 50 A.U.; thence up to $\lambda 20,000$ the error may have amounted to 100 A.U. Prof. McLennan stated that one of his assistants had made measurements to $\lambda 21,000$. Prof. McLennan gave a brief account of some measurements in his laboratory of the series lines in the arc-spectrum of mercury and on their resolution by an echelon grating. In these experiments he found that the best spectrograms were obtained with an ordinary commercial glass Cooper Hewitt mercury lamp provided with a side tube carrying a window made from a plate of crystalline quartz.

Radio-activity and Electronics.

Mr. James Robinson described his experiments on the photoelectric properties of thin metal films showing a discontinuity in the behaviour when the film attains a particular thickness. Prof. Rutherford asked whether this break in the curve implied that the total energy emitted was discontinuous. Prof. McLennan suspected the possibility of a coherer action when the thickness attained a definite limit. In reply to a query by Prof. Millikan, Mr. Robinson stated that the 6-volt electrons obtained corresponded to about the limit capable of producing ionisation. He did not think Prof. McLennan's suggestion fitted in with the facts.

Prof. Millikan summarised his already published experiments on the discharge of ultra-violet light of high-speed electrons, in which far higher velocities were found when a spark is employed from those for a mercury arc. Prof. Strutt suggested that what was required was to bridge over the gap between the arc and spark experiments, and indicated that it might be done by gradually altering the pressure of the gas in which the spark took place. Prof. Millikan replied that he had altered the conditions gradationally. He pointed out that only 1 in about 100,000 electrons have the high velocity. He also read a paper on the law of the fall of a drop through air at reduced pressures and a redetermination of e.

A law of fall of the form—

$$v=\frac{2}{9}\frac{ga^2(\sigma-\rho)}{\mu}\left\{1+A\frac{l}{a}\right\}$$

is found to hold so long as $l/a<0·4$, but beyond that limit an extra term must be added inside the curly brackets, viz. B. exp. $(-ca/l)$, in which A, B, and c are all positive constants. If l is obtained from the Boltzmann formula, $\mu=0·3502mn\bar{c}l$, then $A=0.874$, $B=0·35$, and $c=1·7$. The accurate evaluation of the constant A makes possible a redetermination of e which has a probable error of no more than 1/10 per cent. This value is $e=4·775\times10^{-10}$ E.S. units.

Prof. J. C. McLennan, on the intensity of the earth's penetrating radiation over land and large bodies of water, claimed *inter alia* to prove that the earth's penetrating radiation has practically the same intensity within a brick structure at Cambridge and a stone building in Scotland as within a brick or a stone structure at Toronto; and further to disprove the existence of a diurnal variation of this radiation at Cambridge. Prof. Strutt could not help thinking that it existed.

Prof. E. Rutherford and Mr. H. Robinson contributed a paper on the heating effect of radium emanation and its products. They raised the question as to whether the energy of the alpha particle is a measure of the heating effect produced, and came to the conclusion that there is a distinct difference between these quantities, and thence that there must be a small rearrangement of the original atom. The paper will shortly be published by the Vienna Academy of Science.

In a second paper, Prof. Rutherford discussed the origin of the beta and gamma rays from radio-active substances. The evidence used was afforded by the relations between the energies of the numerous groups of beta rays which are obtained. The simplest way of regarding these relations is to suppose that the same total energy is emitted during the disintegration of each atom, but the energy is divided between beta and gamma rays in varying proportions for different atoms. For some atoms most, if not all, of the energy is emitted in the form of a high-speed beta part, in others the energy of the beta particle is reduced by definite but different amounts (as it might be if, in escaping, it had to pass through successive rings of electrons) by the conversion of part of its energy into that of gamma rays.

Prof. F. Soddy exhibited the apparatus (as shown in his Royal Institution lecture) for drawing the curves of radio-active changes.

Mathematics.

M. Gérardin, of Nancy, described a mechanism for factorising large numbers. By means of this instrument, which is of the nature of a slide rule, factorisation is exceedingly expeditious, *e.g.* the decomposition of Mersenne's number M_{47} required only four minutes. Lieut.-Col. A. Cunningham congratulated the author. With such a machine one would be quite able to investigate the remaining Mersenne's numbers, but he was afraid that it would require to be very large.

Lieut.-Col. Cunningham himself read a paper on Mersenne's numbers. An additional prime factor has been found for M_{71}, viz. 212885833 (due to Mr. Ramesam, of Mylapore); E. Fauquembergue has confirmed that M_{89} is prime; the author has shown that $M_{173}=O(\text{mod. } 730753)$. Thereby three mistakes have now been proved in Mersenne's classification, viz. :—M_{67} proved composite, M_{61} and M_{89} proved prime.

Lieut.-Col. Cunningham, in a second paper, discussed the arithmetical factors of the Pellian terms.

Prof. E. H. Moore dealt with the theory of the composition of positive quadratic forms. The n-ary quadratic form—

$$A=\sum_{i,j=1}^{n} a_{ij}x_ix_j \ (a_{ij}=a_{ji}),$$

with real coefficients a_{ij}, is positive if, for real values of the n variables, x_i, it takes on only positive or zero values. From two such forms, A and B, we obtain by multiplication of corresponding coefficients a third form, C, their inner composite. For this inner composition the property of positiveness is invariant, *i.e.* the inner composition is likewise positive; otherwise expressed, the class of positive n-ary quadratic forms is closed under the process of the inner composition of forms. The theorem in its generality is readily proved by consideration of the fact that a form is positive if, and only if, it is expressible as the sum of squares of a finite number of linear forms with real coefficients. Mr. Hilton suggested that the theorem might be proved by using the fact that the zeros of the characteristic determinants were real and positive. Dr. H. B. Heywood inquired if Prof. Moore had discovered any similar results for quadratic forms other than positive ones. Such results would be of use in the theory of Fredholm's equations. Prof. Moore thought Mr. Hilton's suggestion a good one. He had not discovered any results applicable to the general quadratic form. He had been led to the theorem of his paper by his work on Fredholm's equation.

Prof. J. C. Fields gave a new proof of a general theorem relating to orders of coincidence. Major MacMahon discussed the algebraic functions derived from the permutations of any assemblage of objects. Prof. W. Peddie described an apparatus for the solution of equations of the *n*th degree, which required, however, that the equation should be prepared so that the root required lay between 0 and 1. In reply to a query, he thought that the method would be more expeditious than those usually employed.

Dr. H. B. Heywood described the use of the exponential curve in graphics. For carrying out the processes a template of transparent celluloid is used upon which is marked a graduated exponential curve. Operations of multiplication, division, evolution, differentiation, and integration are performed. The error is not greater than 1 per cent. except for differentiation.

An account was given by Dr. Nicholson of the report of the committee for the tabulation of Bessel and other functions. Four sheets of new tables of elliptic functions are given for four modular angles. These are preceded by a statement by Sir George Greenhill explaining the notation and the mode of using the tables. The report includes some tables (placed at their disposal by Prof. A. G. Webster, who has calculated them) of some *ber* and *bei* functions and their derivatives. These tables will be of especial importance to electrical engineering.

Cosmical Physics and Astronomy.

The report of the committee on seismological investigations contains a detailed account of the various seismic disturbances in the period 1904–09, thus extending the catalogue contained in last year's report. Curves are given, relating to six large earthquakes, showing the relation between the amplitudes in angular measure and the distance from the origin. Sixteen instances are given in which the azimuth of an origin determined from the maxima of the N.S. and E.W. motion approximately agrees with the azimuth as measured on a globe. In the same interval there are twenty-six instances for which no such agreement exists. The inference is that the main portion of teleseismic motion generally takes place in directions independent of the azimuth of its origin. Sections are devoted to the relative duration of two rectangular components of earth movement at a given station, megaseismic frequency in different seasons, earthquake periodicity, a new periodicity (by Prof. H. H. Turner, in which it is shown that besides the period of about fifteen months, there is also evidence that for the world as a whole seismic strain usually finds relief every fifteen or thirty days), and other matters.

Prof. H. H. Turner explained further to the section that further examination showed that some of the deviations may be due to the existence of neighbouring periodicities which have not been fully examined. But attention has been concentrated on the existence of pairs of periodicities or groups (analogous to double lines or groups of spectra) by relative work on the variations of level and azimuth of the Greenwich and Cape transit circles.

In the absence of Mr. J. I. Craig, Prof. Turner read a paper by the former showing that there is a connection between Prof. Schuster's method of analysing a series of figures for suspected periodicities and the method of correlation applied by Prof. Karl Pearson to detect hidden connections between sets of variables.

Dr. S. Chapman, of Greenwich Observatory, gave an account of an attempt to determine the total number of the stars. He also read a paper by Prof. Dyson (the Astronomer Royal) in which it was endeavoured to identify several chromosphere lines as due to radium. Considerable scepticism seemed to be shown by those present whether it was possible at present to make sure of the identity on such short spectra as are obtainable. Prof. Kayser expressed his great interest, but considered that the relative intensities which had been quoted were very uncertain because authorities differed. It was doubtful indeed whether a stated intensity had any meaning. The presence of helium seemed to be a point in favour of the author. Prof. the Hon. R. J. Strutt remarked that the spectral examination of terrestrial minerals would scarcely show the presence of radium, and asked whether the conditions in the chromosphere were such as to enhance the lines or those of allied bodies, such as barium. Prof. Rutherford said he would require very great evidence indeed before accepting spectroscopic evidence of emanation in stars. Dr. Nicholson argued that the presence of helium does not prove the presence of radium. Father Cortie and Dr. Lockyer both emphasised the shortness of the spectra.

In a paper on magnetic disturbances, sun-spots, and the sun's corona, Father Cortie examined the curves for the period 1898–1911 of mean daily disc-area of sun-spots, mean daily range of declination and horizontal force, and yearly numbers of great and moderate magnetic disturbances. There is a general accord in the curves, but also notable discrepancies. F[illegible] example, the rapid fall of sun-spot curve 1909–11 was accompanied by a marked rise in declination, horizontal force and moderate magnetic disturbances.

The committee on magnetic observations at Falmouth Observatory report the following mean values of the magnetic elements for the year 1911:—

Declination	17° 33·0′ W.
Inclination	66° 28·2′ N.
Horizontal force	0·18798 C.G.S.
Vertical force	0·43172.

The meteorological papers read have been described in an earlier article (November 28, p. 369).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Notice is given that the Plumian professorship of astronomy and experimental philosophy is vacant by the death of Sir George H. Darwin, K.C.B.

Mr. H. C. Robson, of Sidney Sussex College, has been appointed chairman of the examiners for the mathematical tripos, part i., 1913, and Prof. Seward chairman of the examiners for the natural sciences tripos, 1913.

The professor of anatomy has appointed Mr. E. R. T. Clarkson an additional demonstrator of anatomy.

The matriculation of December 6 shows a total entry of 1156 freshmen up to the present date for the year 1912–13. This compares favourably with the similar number of last year at the same date, which was 1111.

OXFORD.—On December 10 the honorary degree of doctor of science was conferred on Prof. Ernest

William Hobson, fellow of Christ's College, and Sadlerian professor of pure mathematics in the University of Cambridge.

By special invitation of the University of Calcutta, Dr. A. R. Forsyth, F.R.S., will give a course of advanced lectures in pure mathematics early next year. His subject is "The Theory of Functions of Two or More Complex Variables." The course will consist of sixteen lectures, to be delivered late in January and in February, and the lectures will be published later.

The course of lectures on Indian sociology by Mr. T. C. Hodson will be resumed at East London College (University of London), Mile End Road, E., on Monday, January 13, at 5.30 p.m., when the subject-matter of the lectures will be tree marriage in India, its significance in non-Aryan races, and other forms of substituted marriage. These lectures are free to the public.

The Selborne Society is making a representative exhibit at the Children's Welfare Exhibition (which is to be opened at Olympia on December 31), to show what is best in nature-study and its uses to boys and girls. All who are interested in the subject are invited to communicate with Mr. Wilfred Mark Webb, 42 Bloomsbury Square, W.C., so that he may send them the outline scheme which it is intended more particularly to follow and learn what matters of value they could offer to illustrate it.

In view of the success of the first Summer School of Town Planning, held at the Hampstead Garden Suburb in August last, under the auspices of the University of London, it has been decided to hold a second summer school next year at the same centre. It will last for a fortnight, commencing August 2, and continuing until August 16, and during that time lectures and demonstrations on town planning and subjects practically connected therewith will be given by some of the leading authorities. Particulars can be obtained upon application to the hon. secretary of the Summer School, Mr. J. S. Rathbone, The Institute, Hampstead Garden Suburb, London, N.W.

A course of lectures and practical instruction on physical anthropology will be given in the anatomy departments of University College and King's College, London, by Prof. D. Waterston and Dr. D. E. Derry. The course will begin on Tuesday, January 14, at University College, and will comprise the following branches of the subject:—Cranioscopy; craniometry; osteometry; anthropometry (on the living subject); estimate of stature, age, and sex from bones; comparison with higher mammals, especially anthropoidea; and race distribution and characteristics. Further particulars may be had on application to the secretary of King's College, or to the secretary of University College.

The Eugenics Education Society has arranged for three courses of lectures upon the groundwork of eugenics, to be given at the Imperial College of Science, South Kensington, from January to December, 1913. In the spring term (January to March) there will be a course of twelve lectures on elementary biology, with special reference to the reproductive system, by Mr. Clifford Dobell; in the summer term (April to July), a course of twelve lectures on heredity, including evolution, genetics, and heredity in man, by Prof. R. C. Punnett, F.R.S.; and in the autumn term (October to December), a course of twelve lectures on statistical methods applied to some problems in eugenics, by Mr. G. Udny Yule.

In connection with the Francis Galton Laboratory for National Eugenics, a course of six lectures will be delivered at University College, London, by Prof. Karl Pearson, F.R.S. (Galton professor of eugenics), Miss Ethel M. Elderton, Dr. David Heron, and Mr. W. Palin Elderton. These lectures will be given on Tuesday evenings at 8 p.m., beginning February 11, 1913, and will deal with the following subjects: Heredity, environment and parental habits in their relation to infant welfare; heredity of piebaldism and of albinism in man; the relation of fertility in man to social value in the parent; some points with regard to our present knowledge of heredity in cases of feeble-mindedness; the mortality of the phthisical under sanatorium and tuberculin treatments; and recent studies of heredity in dogs, and their bearing on heredity in man. The course will be open to the public without fee, but applications for tickets should be addressed to the secretary of University College.

The scheme for the rebuilding of College Hall—a hall of residence for women students of London University—has already been referred to in these columns. At a combined meeting of the trust fund committee and the executive committee of the site and rebuilding funds held last week, the chairman of the executive committee, Dr. Gregory Foster, announced that the committee, on reporting the scheme to the Queen, had obtained the gratifying response "that the object was one which met with her Majesty's entire approval," and that "so soon as the necessary funds have been raised to complete the scheme the Queen will be prepared to give her favourable consideration to the question of College Hall being named after her Majesty." With regard to these funds, it was stated that of the total sum of 30,000*l.* required, more than 9500*l.* has been obtained within the first year. It was decided to make a strong appeal, both publicly and privately, for the 20,500*l.* necessary to complete the scheme.

SOCIETIES AND ACADEMIES.

London.

Geological Society, November 20.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—H. W. **Monckton**: The Hafslo Lake and the Solvorn Valley (Norway). The district lies north of the main Sogne Fjord and west of the Lyster Fjord. A series of valleys running from the area of the Jostedal snowfield and cutting the belt of Silurian rocks which crosses the district in a north-easterly and south-westerly direction, and a second series of valleys which run parallel to the snowfield and to the Silurian belt, are described. The valley of the Vejtestrands Lake, which belongs to the first of the above series, is traced until it reaches the Hafslo Lake, which lies at a point where the valleys of the two series intersect. The present line of drainage follows a valley of the second series from the lake to the fjord, but a disused outlet from the lake to the fjord is described belonging to the first series. While the disused outlet is probably the older of the two, reasons are given for believing that both outlets were in use during the latter part of the glacial period. Some giants' kettles, which for various reasons are believed to date from a time when the glacier extended to the places where they are now found, are described, and it is suggested that they were the work of a river flowing under the ice or between the ice and the rock.—S. **Smith**: The genus Aulophyllum. Aulophyllum is a genus belonging to the Clisiophyllid group. It is found in the upper beds of the Carboniferous Limestone Series in Britain and on the Continent. It appears in the lower part of the Dibunophyllum zone (D_1), becomes common in the middle subdivision of the zone (D_2), and is plentiful in the highest limestones investigated (D_3). The coral was described first by David Ure, in 1793, as Fungites; the genus was established by Milne-Edwards and Haime in 1850. In this genus Thomson's genus Cyclophyllum is included. All the species previously described are regarded as variations of the same species. Many specimens of the coral display the phenomenon of rejuvenescence. The structural changes observed are described, and the nature of the rejuvenescence is discussed.

EDINBURGH.

Royal Society, November 18.—Dr. John Horne, F.R.S., vice-president, in the chair.—Prof. W. **Peddie**: The deviation of the law of torsional oscillation of metals from isochronism. It was found that, in spite of the effect of viscosity, even though that were so great as to cause, during a semi-oscillation, a fall in amplitude to one-third of the original value, the law of oscillation throughout the greater part of a semi-oscillation could be represented by a simple harmonic function.—James B. **Ritchie**: A fuller test of the law of torsional oscillation of wires and a continued investigation on the behaviour of certain torsionally oscillating wires. The investigations had been extended to brass and aluminium wires at high temperatures, and to various other wires at ordinary temperatures. The effects of quenching and of magnetisation were also studied. In the case of a copper wire on the surface of which zinc had been deposited electrolytically to various thicknesses, the parameters in the formula for relation of torsional swing to number of swings changed gradually from those characteristic of the one metal to those characteristic of the other.—J. P. **Dalton**: The energetics of the induction balance. When the arms of a Wheatstone Bridge contain capacities and inductances, as well as resistances, the formulæ appropriate to the methods for measuring capacities and inductances can be deduced from the relations between the electrostatic and electrokinetic energies.—R. A. **Robertson** and Miss Rosalind **Crosse**: Periodicity in plants. Experiments were described which proved the existence of a four-day growth rhythm of wide occurrence in plant organs. By means of a specially arranged apparatus simultaneous records were taken of the growth of the shoot and the root, and these showed a correlative affectability between the organs.—Dr. Thomas **Muir**: Theory of axisymmetric determinants from 1857 to 1880.

PARIS.

Academy of Sciences, November 25.—M. Lippmann in the chair.—G. **Bigourdan**: Fifth list of nebulæ discovered at the Observatory of Paris.—L. **Maquenne** and E. **Demoussy**: The determination of the true respiratory coefficient of plants. In a preceding communication it has been shown that the true respiratory quotient for plants is always higher than the apparent ratio given by the confined air method, and it is very difficult to apply corrections to the latter. An accurate method is described, called the displacement method, and results obtained by this and the vacuum method compared for numerous plants.—M. **Gouy**: The simultaneous action of gravity and a uniform magnetic field on an ionised gas. The apparent contradiction between the kinetic theory and Carnot's principle disappears if the ions arise on the walls of the vessel at the same time as in the body of the gas, according to a determined relation.—Serge **Bernstein**: The asymptotic value of the best approximation of analytical functions.—Rodolphe **Soreau**: The reduction of $F_{123}=0$ to the form $f_1f_3+f_2g_3+h_3=0$.—L. **Thouveny**: The volplane. A mathematical study of the conditions under which a bird floats in the air in a wind.—M. **Mesnager**: An experimental method for determining in advance the tensions produced in buildings.—Carl **Störmer**: Remarks on a note of M. Kr. Birkeland relating to the origin of the planets and their satellites. A paper published by the author in 1907 on the movement of an electrified particle in the field of an elementary magnet can be directly applied to the hypothesis of the origin of planets of M. Birkeland. É. **Rothé**: The reception of wireless signals by antennæ on the ground. Using a horizontal wire from 15 to 35 metres in length and supported only 15 cm. from the ground near Saint-Dié, the Eiffel Tower signals were clearly heard. The garden in which these experiments were carried out was entirely surrounded with a metallic trellis more than one metre high.—Léon and Eugène **Bloch**: The ionisation of the air by a mercury arc in quartz. A distinct ionising action of the arc on the air was proved.—A. **Henry**: A micromanometer. The manometer consists of two wide vertical tubes connected by a narrow horizontal tube. Carbon tetrachloride is used as the fluid, and a small bubble of air is introduced into the horizontal tube. Differences of level corresponding to 0·005 mm. of water are shown by the movement of the bubble. Various possible applications of this micromanometer are enumerated.—A. **Boutaric**: The critical coefficient and the molecular weight of bodies at the critical point.—Eugène L. **Dupuy** and A. **Portevin**: The thermoelectric properties of the system iron-nickel-carbon. Experiments were made with thirty analysed alloys containing varying proportions of nickel; the results are shown graphically in six curves.—M. **Hanriot** and F. **Raoult**: The chemical reactions of β-gold and crystallised gold. A study of the solution of the two forms of gold by solutions of nitric and hydrochloric acids and of auric chloride.—E. **Léger** and Ferdinand **Roques**: Carpiline, a new alkaloid from jaborandi. Details of the method of extraction and chemical and physical properties of the new alkaloid are given, together with some preliminary experiments to determine its constitution.—Aug. **Chevalier**: The introduction of the clove (*Carophyllus aromaticus*) into Gabon.—A. **Lamothe**: The gametophyte of the Marchantiaceæ and the importance of its anatomical characters.—J. **Stoklasa**: The influence of radio-activity on the development of plants. Radio-active water causes a prompt germination and a very rapid development of the leaves and roots of plants, provided that the radio-activity does not exceed a certain limit; above this limit the action is deleterious.—V. **Grégoire**: The truth of the heterohomeotypical scheme.—C. **Delezenne** and Mlle. S. **Ledebt**: New contribution to the study of the hæmolytic substances derived from serum and from the vitellus of the egg submitted to the action of cobra poison.—Henri **Iscovesco**: The physiological properties of certain lipoids. The homo- and hetero-stimulant lipoids of organs. A lipoid extracted from the ovary, injected into rabbits, produced marked hypertrophy of the ovary. The action was specific, all the other organs remaining normal. A lipoid extracted from the testicle of the horse was also found to exert a similar specific action in rabbits.—J.-P. **Langlois** and G. **Desbouis**: The duration of the pulmonary circulation. The method followed was a modification of that due to Stewart. Curves are given showing the action of varying amounts of digitalin and chloroform and ether on the duration of the pulmonary circulation.—A. **Desmoulière**: The antigen in the Wassermann reaction. Further experiments showing the constancy and high sensibility of the antigen prepared by the method described in a previous paper.—A. **Magnan**: Variations in the digestive apparatus of ducks produced by various kinds of foods.—Jacques **Pellegrin**: The ichthyological fauna of the coasts of Angola.—R. **Fourtau**: The divisions of the Eocene in Egypt.—G. **Vasseur**: The vertebrate fauna discovered in the upper Aquitanian of Agenais.

December 2.—M. Lippmann in the chair.—A. **Lacroix**: The existence of nepheline rocks in the crystalline schists of Madagascar. Details of the appearance, occurrence, and composition of a nepheline gneiss and its comparison with a similar rock of Portuguese origin.—Charles **Depéret**: The Oligocene of the Roanne basin and its fauna of fossil mammals. —Ph.-A. **Guye** was elected a correspondent for the Section of Chemistry in the place of Adolf von Baeyer, elected foreign associate, and M. **Balland** a correspondent for the Section of Rural Economy, in the place of the late M. Pagnoul. Charles **Gallissot**: Contribution to the study of scintillation. The effect of twinkling of a star has been studied from the photometric point of view. It leads to an error in the determination of the magnitude of a star depending on the change of colour. Patrick **Browne**: A problem of inversion proposed by Abel.—M. **d'Ocagne**: The reduction of equations with three variables to the canonical forms.—M. **Roussilhe**: The variation of levels in the Congo rivers. The Congo basin is divided into two distinct zones, in only one of which there is a clear seasonal variation, culminating at definite dates. —M. **Charcot**: Maps of the second French Antarctic expedition.—C.-G. **Darwin**: Remarks on the communication of M. Gouy on the theory of ionised gases and Carnot's principle. Reasons are adduced showing that the case imagined by M. Gouy in opposition to Carnot's principle is impossible, and that a magnetic field will not alter a statistical distribution of the ions.—L. **Houllevigue**: The reflection of slow kathode rays.—E. **Briner**: The limit of formation of endothermic compounds at very high temperatures. In the van't Hoff equation for the equilibrium of the reaction between N_2 and O_2, with production of nitric oxide, the heat of reaction is negative. If, however, the temperature of the reaction is sufficiently high to dissociate entirely the molecules of nitrogen and oxygen the heat of reaction will be negative and the concentration of NO will then diminish with rise of temperature. The increase of dissociation of the elementary molecules will thus lead to a temperature for which the concentration of the nitric oxide will pass through a maximum.—Henri **Bierry**, Victor **Henri**, and Albert **Ranc**: The inversion of saccharose by the ultra-violet rays. Experiments are described proving that the hydrolysis of the saccharose produced after irradiation either in neutral solution or slightly acid solution, in presence or absence of oxygen, is a direct product of the action of the ultra-violet rays.—Daniel **Berthelot** and Henri **Gaudechon**: The photolysis of several kinds of sugars by ultra-violet light. The gases produced by the degradation of sugars by ultra-violet light consist of carbon monoxide and hydrogen in simple proportions.—Marcel **Guerbet**: The action of caustic potash on *cyclo*hexanol; the synthesis of *cyclo*hexanyl*cyclo*hexanol and of di*cyclo*hexanyl*cyclo*hexanol. Lucien **Daniel**: The grafting of *Nasturtium officinale* on *Brassica oleracea*. An example of the effect of modifying the habitat of one or both of the plants on successful grafting.—M. **Servettaz**: Cultures of mosses in sterilised media.—Mlle. Marie **Korsakoff**: Researches on the variation of fats, sugars, and of saponine in the course of the ripening of the seeds of *Lychnis Githago*. Marc **Bridel**: The presence of gentiopicrin, gentianose, and of saccharose in the fresh roots of *Gentiana Asclepiadea*. G. **Gin**: The black earths of the valley of l'oued R'Dom in Morocco.—P. **Nottin**: A study of manganese in its relation to soils. Arable earth renders manganese salts insoluble, and retains it in a manner analogous to that in which it absorbs ammonia, potash, and phosphoric acid.—Pierre **Teissier** and Pierre **Gastinel**: Reactions in human and experimental vaccine. J. **Bergonié**: The applications of diathermy as forming part of the energy balance of the body. An account of the therapeutic action of d'Arsonval's method of using high-frequency currents of low electromotive force. Details are given of the application of this method to one case in which a marked improvement resulted.—M. **Ardin-Delteil**, L. **Nègre**, and Maurice **Raynaud**: The vaccin-therapy of typhoid fever. An account of the application of Besredka serum in thirty-seven cases. The gravity of the disease was reduced, not one death in the thirty-seven cases taking place. The number of relapses was reduced to about one-half of the average, and the duration of the disease appeared to be somewhat shortened.—Henri **Piéron**: The relation connecting the time of latency of reaction and the intensity of stimulation.—E. **Kohn-Abrest**: The action of active aluminium on alkaloidal extracts. Its use in toxicology. Amalgamated aluminium may be used for purifying visceral extracts from fatty and colloidal impurities. Certain alkaloids, such as strychnine, quinine, and cocaine, are partially retained by the aluminium, whilst nicotine is almost totally retained. Other alkaloids examined were not appreciably retained by the aluminium.—B. **Sauton**: The comparative influence of potassium, rubidium, and cæsium on the development of the spores of *Aspergillus niger*.—A. **Trillat** and M. **Fouassier**: The action of infinitesimal doses of various alkaline, fixed, or volatile substances on the vitality of micro-organisms.—H. **Agulhon** and R. **Sazerac**: The increase of activity of certain microbial oxidation processes by uranium salts.—Philippe de **Vilmorin**: Observations on the Glandinæ at Verrières-le-Buisson.—A. **Brachet**: The development *in vitro* of blastoderms and young embryos of mammals.—Charles **Jacob**: The local glacial deposits of Vercors and the neighbourhood of Villard-de-Lans.—J. **Assada**: The morphological study of the terraces in the neighbourhood of Lyons.—Alphonse **Berget**: The magnetic rôle of the oceans and the constitution of the earth's crust.—De Montessus de **Ballore**: The earthquakes of the Baltic provinces of Russia (Esthonia, Livonia, and Courland).—A. **Laborde** and A. **Lepape**: Study of the radio-activity of the Vichy springs and of some other spas.

BOOKS RECEIVED.

A Manual of Zoology. By Prof. R. Hertwig. Third American from the Ninth German Edition. Translated and edited by Prof. J. S. Kingsley. Pp. xii+606. (New York: H. Holt and Co.)

The American Annual of Photography, 1913. Vol. xxvii. Edited by P. Y. Howe. Pp. 328. (New York: G. Murphy, Jun.) 75 cents.

Mathematics from the Points of View of the Mathematician and of the Physicist. By Prof. E. W. Hobson. Pp. 24. (Cambridge University Press.) 1*s.*

Radioactive Substances and their Radiations. By Prof. E. Rutherford. Pp. vii+699. (Cambridge University Press.) 15*s.* net.

The Concept of Sin. By Dr. F. R. Tennant. Pp. v+282. (Cambridge University Press.) 4*s.* 6*d.* net.

The Geology of Soils and Substrata, with Special Reference to Agriculture, Estates, and Sanitation. By H. B. Woodward. Pp. xiv+366. (London: E. Arnold.) 7*s.* 6*d.* net.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1913. Edited by G. E. Brown. Pp. 1448. (London: H. Greenwood and Co.) 1*s.* 6*d.* net.

University of California Publications in American Archæology and Ethnology. Elements of the Kato Language. By P. E. Goddard. Pp. 176+45 plates. (Berkeley: University of California Press.)

Guide to the Collection of Gemstones in the Museum of Practical Geology. By W. F. P. McLintock. Pp. iv+92. (London: H.M.S.O.; E. Stanford, Ltd.) 9*d*.

From Pole to Pole. By Sven Hedin. Pp. xv+407+xxxix plates and maps. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

The Pagan Tribes of Borneo. By Dr. C. Hose and W. McDougall. Two vols. Vol. i., pp. xv+283+143 plates. Vol. ii., pp. x+374+211 plates+4 maps. (London: Macmillan and Co., Ltd.) Two vols., 42*s*. net.

A First Class-book of Chemistry. By E. Barrett and Dr. T. P. Nunn. Pp. iv+124. (London: A. and C. Black.) 1*s*. 6*d*.

Die Elektrizität. By Prof. F. Adami. Pp. 126+4 plates+180+12 plates. (Leipzig: P. Reclam, Jun.) 1.50 marks.

Kosmologische Gedanken. By W. Baratsch. Zweite Auflage. Pp. 55+63. (Leipzig: F. E. Fischer.) 1.50 marks.

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. Lief 29. Band I. Zweite Hälfte. Pp. 321–480. (Jena: G. Fischer.) 5 marks.

Analyse des Matières Colorantes Organiques. By Dr. F. Reverdin. Pp. 56. (Geneva and Basle: Georg and Co.)

Vaccine Therapy: its Theory and Practice. By Dr. R. W. Allen. Fourth edition. Pp. x+444. (London: H. K. Lewis.) 9*s*. net.

Teacher's Manual of Biology. By Prof. M. A. Bigelow. Pp. ix+113. (London: Macmillan and Co., Ltd.) 1*s*. 8*d*. net.

A Laboratory Manual of Agriculture for Secondary Schools. By Prof. L. E. Call and E. G. Schafer. Pp. xv+344. (London: Macmillan and Co., Ltd.) 4*s*. net.

Mineralogy. An Introduction to the Theoretical and Practical Study of Minerals. By Prof. A. H. Phillips. Pp. ix+699. (London: Macmillan and Co., Ltd.) 16*s*. net.

Deutsches Museum: Lebensbeschreibungen und Urkunden. Georg von Reichenbach. By W. v. Dyck. Pp. iv+140+viii plates. (München: Selbstverlag des Deutschen Museums.)

Ueber einfache Pflanzenbasen und ihre Beziehungen zum Aufbau der Eiweissstoffe und Lecithine. By Dr. G. Trier. Pp. iv+117. (Berlin: Gebrüder Borntraeger.) 5.60 marks.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 12.

MATHEMATICAL SOCIETY, at 5.—Recent Advances in the Theory of Surfaces. Address by the ex-President (Dr. H. F. Baker), postponed from the November Meeting.—A Connection between the Functions of Hermite and Jacobi: H. E. J. Curzon.—The Equations of the Theory of Electrons Transformed Relative to a System in Accelerated Motion: H. R. Hassé.—The Convergence of Series of Orthogonal Functions: E. W. Hobson.—The Determination of the Nature of a Function from a Knowledge of One of its Derivatives: W. H. Young.—Mersenne's Primes: J. McDonnell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—A Single Phase Motor with Pole Changing Windings: J. S. Nicholson and B. P. Haigh.

ROYAL SOCIETY OF ARTS, at 4.30.—Delhi, the Metropolis of India: Sir Bradford Leslie, K.C.I.E.

CONCRETE INSTITUTE, at 7.30.—The Action of Acids, Oils and Fats upon Concrete: W. Lawrence Gadd.

FRIDAY, DECEMBER 13.

ROYAL ASTRONOMICAL SOCIETY, at 5. The Long Period Variable V Cassiopeiæ (Ch. 8324) in 1910–12: A. N. Brown.—Observations of the Magnitude of Nova Geminorum 2, made at the Royal Observatory, Edinburgh: H. Jameson.—Note on R Cygni: Heber D. Curtis.—The Distribution in Latitude of the Absorption Markings in Hα Spectroheliograms: T. Royds.—Baxendell's Observations of Variable Stars. Edited by M. A. Blagg and H. H. Turner. No. 1: R. Arietis.—*Probable Papers*: Note on the Cambridge Magnitude Equation: F. A. Bellamy.—Note on a New Similarity between the Variations of S Persei (and other Long Period Variables) and the Variations of Sun-spots: H. H. Turner.—Observations of the Principal and other Series of Lines in the Spectrum of Hydrogen: A. Fowler.

MONDAY, DECEMBER 16.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—From the Victoria Nyanza to the Kisii Highlands: Dr. Felix Oswald.

ARISTOTELIAN SOCIETY, at 8.—New Logic and Old: Miss E. E. Constance Jones.

ROYAL SOCIETY OF ARTS, at 8.—Methods of Economising Heat: C. R. Darling.

INSTITUTE OF ACTUARIES, at 5.—Some Observations on Currency and Credit and their Influence on Trade and Exchange: W. T. May.

TUESDAY, DECEMBER 17.

ROYAL STATISTICAL SOCIETY, at 5.—Presidential Address, The Use of the Mathematical Theory of Probabilities in Statistics Relating to Society: Prof. F. Y. Edgeworth.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* The Generation and Distribution of Producer-gas in South Staffordshire: H. A. Humphrey.

WEDNESDAY, DECEMBER 18.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Probable Utility of Salinity Observations in the Irish Sea for Long-date Weather-forecasting: Prof. H. Bassett.—Air Currents at a Height of 50 miles: J. E. Clark.—New Form of Standard Barometer: C. Anthony.

GEOLOGICAL SOCIETY, at 8.—The Discovery of a Human Skull and Mandible in a Flint-bearing Gravel at Piltdown, Fletching (Sussex): C. Dawson and Dr. A. Smith Woodward.

ROYAL SOCIETY OF ARTS, at 8.—The Pictorial Possibilities of Work: Joseph Pennell.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Insect Intelligence: F. Enoch.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, DECEMBER 19.

LINNEAN SOCIETY, at 8.—Experiments on the Pollination of our Hardy Fruits: C. Hooper.—The Morphology and Histology of Piper Betle, Linn: H. M. Chibber.—Some New British Plants: G. Claridge Druce.—Wild Rice, Annual and Perennial: Dr. Otto Stapf.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Work of the International Electro-technical Commission: Dr. S. P. Thompson.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, DECEMBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Further Discussion:* Vapour-Compression Refrigerating Machines: J. Wemyss Anderson.—A Contribution to the Theory of Refrigerating Machines: J. H. Grindley.

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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THURSDAY, DECEMBER 19, 1912.

PRODUCTION AND THE PUBLIC REVENUE.

Principles of Economics. Vol. ii. By Dr. N. G. Pierson. Translated from the Dutch by A. A. Wotzel. Pp. xxiii + 645. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* net.

THERE is much to be said both for and against the method adopted by the late Dr. Pierson of treating Value in Exchange and Money first, and dealing afterwards with Production and Public Revenue in the volume before us. Certainly some of the treatment has been narrowed, because much that rightly belongs to production has found a place in the earlier chapters, but the author has dealt admirably with the remaining phases of the subject.

His opening chapter reminds us that to define production in an economic sense is far from easy. He holds that such production is confined to material goods, either taking the form of increasing them in quantity, or bringing them into a condition to afford greater utility. He refuses to admit any production of immaterial utilities within his definition, thus taking too little account of "productive powers." J. S. Mill, it may be remembered, talked of "utilities fixed and embodied in human beings," which included those qualities that make a man industrially efficient. A truer view, therefore, would hold that production, as understood in economics, includes the creation or preservation of such powers, whether the labour consist of training producers or restoring them, when sick, to full health and vigour. The narrower definition, however, has some advantage in clearness.

Production, as thus defined, is considered in relation to Self-Interest, Population, Protection, and Land Tenure. The author was fundamentally opposed to Socialism, but no blind adherent of *laissez-faire*. Its defects are well illustrated in connection with depressions and crises and the interest of the working classes, and a strong point is made of those influences which act ultimately and mainly for good, but only after causing serious losses to individuals. Such faults are further aggravated by a too rapid growth of population, and Dr. Pierson gives a powerful criticism of the principle of Malthus and a restatement of it in the light of modern conditions. The final chapter of this part contains an admirable historical and descriptive treatment of land tenure in different countries.

The revenue of the State is of three kinds, or four if loans may be regarded as a source of income of the same order as the others. These are, first, returns from public domains or enterprises run on business lines; secondly, fees paid for a "measurable special benefit," or service performed by the State, in cases where there is a "predominant public purpose" and profit-making is a secondary consideration; and, thirdly, taxes, or "compulsory contributions from the public funds," which do not consist of special payments for some service rendered. The latter naturally occupy most of the space, and are treated in two chapters on the pressure and regulation of taxation. It only remains to add that Mr. Wotzel's really admirable translation shows to the best advantage the many merits of the book. For whilst some of its views may or may not meet with acceptance, its force, lucidity, and suggestiveness will scarcely be called in question.

N. B. DEARLE.

CHEMICAL BOOKS AND TABLES.

(1) *Landolt-Börnstein physikalisch-chemische Tabellen.* Vierte Auflage. Herausgegeben von Dr. Richard Börnstein und Dr. Walther A. Roth. Pp. xvi + 1313. (Berlin: Julius Springer, 1912.) Price 56 marks.

(2) *The Elements of Qualitative Chemical Analysis.* With special consideration of the application of the Laws of Equilibrium and of the Modern Theories of Solution. By Prof. J. Stieglitz. Parts i. and ii., Fundamental Principles and their Application. Pp. xi + 312. Price 1.40 dollars. Parts iii. and iv., Laboratory Manual. Pp. viii + 151. Price 1.20 dollars. (New York: The Century Co., 1911–12.)

(3) *A College Text-Book on Quantitative Analysis.* By Prof. H. R. Moody. Pp. vi + 165. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 5*s.* 6*d.* net.

(4) *A Laboratory Manual in Chemistry.* By Prof. W. C. Morgan and Prof. J. A. Lyman. Pp. xiii + 142. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 1*s.* 8*d.* net.

(5) *Elementary Chemical Theory and Calculations.* By Dr. J. Knox. Pp. vii + 103. (London: Gurney and Jackson, 1912.) Price 2*s.* net.

(1) THE new edition of the Landolt-Börnstein tables has been very greatly enlarged and covers nearly 500 pages more than the previous edition. Almost every section of the tables has contributed to this increase: it is therefore impossible to direct attention to all the features which are characteristic of the new edition. There is, however, a marked development in the use of graphic methods which will be very widely welcomed. Thus the equilibrium-diagrams for

metallic alloys have been increased in number from 54 to 251, and a series of 149 equilibrium-diagrams for binary mixtures of fused salts, including many minerals, makes its appearance for the first time. The interval of eleven years which elapsed between previous editions of the tables has now been reduced to seven years only; this appears to be justified by the vast multiplication of numerical data, as illustrated, for instance, by the fact that the "Annual Tables" for 1910 cover more than 700 pages; but the issue of frequent editions, each of which renders the earlier ones obsolete, will tend to confine the tables more and more to the shelves of reference-libraries. The new edition is the first to be issued since the death of Prof. Landolt; it is, therefore, only fitting that a handsome portrait of the originator of the tables should appear as a frontispiece to the new volume.

(2) Complaint has frequently been made that qualitative analysis is liable to degenerate into an unintelligent use of specific tests. Prof. Stieglitz, in his two volumes on qualitative analysis, has removed the subject to the opposite pole by treating it from the point of view of the advanced student of physical chemistry. To the average student, this treatment would probably present considerable difficulty, unless he should be fortunate enough to attend Prof. Stieglitz's own lecture courses and hear his explanations at first hand. Under other conditions there might be some disadvantage in placing the book directly in the hands of the student; but nothing but good can accrue from the assimilation of the contents of the two volumes by teachers responsible for conducting classes in qualitative analysis; they will then be provided with authentic explanations of the more puzzling reactions, and can hand on to their students as much of the underlying theory as may be practicable or desirable. It may be noted that the author has used to some extent the novel scheme of qualitative analysis described by A. A. Noyes and Bray in the Journal of the American Chemical Society.

(3) In the "College Text-book of Quantitative Analysis" concise directions for each step of the analysis are given, with numbered references to "explanatory facts" which justify the procedure adopted. These play the part of footnotes, but are of sufficient importance to justify their appearance in full-sized type on the same page as the instructions for working. It is claimed that by this system the student is saved from the vast waste of time which results from mistakes which are made before the instructor has been able to give personal attention to each individual. By the use of these minute directions, the student at once gets into the habit of correct manipulation, accomplishes more in the same time, and, for a beginner, gets unusually good results. Although a few minor criticisms might be made, the procedure (which was tested with the help of manuscript copies of the book during five years before publication) appears to be thoroughly sound, and teachers would be well advised to examine the book and determine how far it conforms to their own requirements. The directions for gravimetric analysis are particularly good.

(4) The "Laboratory Manual" is intended to accompany the authors' "Chemistry, an Elementary Text-book." It is suggested that the book "will prove interesting to teachers who wish to present that kind of chemistry which appeals to students because of its intense human interest." This view is probably responsible for the introduction of mixtures of potassium chlorate and sugar and of cream of tartar and carbonate of soda into the earliest chapters. But it may be questioned whether any useful purpose can be served by attempting to make chemistry popular with boys by the help of fireworks; in any case, the treatment appears to be extremely scrappy and vastly inferior to courses, such as those based on the British Association syllabus, which are now coming so extensively into use in this country. In this instance, at least, any attempt to copy American methods would involve a retrograde step.

(5) In the "Elementary Chemical Theory and Calculations" numerical exercises are provided to illustrate the chief quantitative laws, of which a brief discussion is also given. There is an ample selection of examples, but many of these are somewhat widely removed from actual laboratory practice, as, for instance, where sodium is made to combine directly with bromine to give a quantitative yield of sodium bromide, or where exact numbers of grains of hydrogen are made to combine with other elements: the value of the book would have been increased greatly if more real and fewer fictitious examples had been given, and especially if use had been made of the vast array of exact analyses which have been accumulated in the course of a century's work in the determination of atomic and molecular weights. T. M. L.

BOTANICAL AND GARDENING BOOKS.

(1) *Nervation of Plants.* By F. G. Heath. Pp. vii+187. (London: Williams & Norgate, 1912.) Price 3s. 6d. net.

(2) *Wild Flowers as They Grow.* Photographed in Colour Direct from Nature. By H. Essenhigh Corke. With descriptive text by G. Clarke Nuttall. Fourth Series. Pp. viii+200. (London: Cassell & Co., Ltd., 1912.) Price 5s. net.

(3) *British Violets.* A Monograph. By Mrs. E. S. Gregory. With an introduction by

G. Claridge Druce. Pp. xxiii + 108. (Cambridge: W. Heffer & Sons, Ltd., 1912.) Price 6*s.* net.

(4) *The Rock Garden.* By Reginald Farrer. Pp. xi + 118 + 8 coloured plates. (London and Edinburgh: T. C. & E. C. Jack, n.d.) Price 1*s.* 6*d.* net. (Present-Day Gardening.)

(5) *Tulips.* By Rev. Joseph Jacob. Pp. xi + 116 + 8 coloured plates. (London and Edinburgh: T. C. & E. C. Jack, n.d.) Price 1*s.* 6*d.* net. (Present-Day Gardening.)

(1) THE author of this work has written much and pleasantly upon ferns and trees, but here he has ventured into a field with which he is unfamiliar. The natural sciences, unfortunately, lend themselves too readily to arrant book-making when *cacoëthes scribendi* gains the upper hand, but that affliction is no excuse for a bad book nowadays, when it is easy enough to get a sufficient first-hand acquaintance with the elements of botany to enable the compiler of "popular" works to read with understanding some of the many excellent botanical text-books published in recent years and, where necessary, translate or paraphrase their diction into easier language for the benefit of a wider audience.

The object of the present work is apparently—by inference from the somewhat jumbled arrangement of the chapters—to describe in simple style the anatomy and physiology of "the two great divisions of the vegetable kingdom called respectively endogenous and exogenous plants," as the author puts it. The first and longest chapter, describing the venation of leaves, omits everything that is really interesting—the relation between venation and the outline and composition of simple and compound leaves, leaf mosaics, etc. though it is at any rate free from the blunders to be found on almost every page in the rest of the book. We are told that, in addition to protoplasm, there are "in all, no less than twelve substances found within the cells of plants," namely, "chlorophyll, dextrine, gum, lime, oil, phosphorus, resin, salts, silica, starch, sugar, and turpentine." This greatly simplifies the biochemistry of plants. The structure of the "exogenous" stem is also elucidated, for we learn that the pith serves for the conduction of water by capillarity, as also do the bast fibres: the pith, moreover, produces the spiral vessels at its periphery, these give rise to the woody zone (showing "annular rings"), and this in turn produces the cambium, the functions of which are shrouded in mystery and doubt. The author's favourite words are "mystery" and "mysterious," often used several times in a sentence and hundreds of times in the whole book.

(2) The plates in the fourth volume of "Wild Flowers as They Grow" fully maintain the high standard of excellence shown in the preceding volumes of the series; the blackthorn, guelder-rose, and white water-lily are exquisitely portrayed, and most of the other plants are extremely good, though some of the colours are scarcely true to nature. Some of the text-figures are, as in previous volumes, too small and poorly executed to be of much service in illustrating the floral mechanisms described in the text. The latter is perhaps too largely occupied with folklore and quotations from herbalists and poets; but more attention is paid to the biology of the plants dealt with than is usually the case in books of this class, and the author has taken care to refer to the available modern text-books for details of pollination and other biological adaptations. The author correctly describes the bird's-nest orchid as a saprophyte—it is too often stigmatised as parasitic in "popular" books—but he might have proceeded to explain the mycorhiza or symbiosis between the plant and its root-inhabiting fungus, which is not mentioned. Like its predecessors, this volume, attractively got up, pleasantly written, beautifully illustrated with coloured plates, and remarkably cheap withal, will command a wide circulation among the increasing circle of readers interested in wild flowers.

(3) Mrs. Gregory's monograph of the British violets, the outcome of her long-continued and careful study of these protean and difficult forms, illustrates the usual result of the intensive method in systematic botany. In Hooker's "Student's Flora," published in 1884, the British violets occupy two pages, with descriptions of six species and seven other forms (sub-species, varieties, hybrids); Mrs. Gregory describes twelve species and more than sixty varieties, forms, and hybrids. Such studies as this, though adding to the troubles of the average field botanist who is content with the simple "lumping" method and finds the larger genera of flowering plants difficult enough without the "splitting" which modern systematists have done with small genera like Viola or Fumaria, are invaluable and prepare the way for further work on variation, hybridisation, and ecology.

(4, 5) These two additional volumes in the excellent "Present-day Gardening" series are of unusual interest and value. Mr. Farrer's work on alpine plants fully deserves the eulogies paid by Prof. Farmer in his preface to this volume on "The Rock Garden," into which the author has packed an amazing amount of invaluable information and advice, such as will be more serviceable to the rock gardener than a score of the innumerable tomes already published on this branch of horticulture. In his volume on "Tulips," Mr. Jacob has successfully surmounted the difficulties of the pioneer—for this is stated by the editor of the series to be the first book on the tulip published in English—and has produced a delightfully readable as well as practical treatise on this interesting genus and its cultivation in times past and present. F. Cavers.

OUR BOOKSHELF.

Catalogue of the Serial Publications possessed by the Geological Commission of Cape Colony, the Royal Observatory, the Royal Society of South Africa, the South African Association for the Advancement of Science, the South African Museum, and the South African Public Library. With an Appendix containing a List of the Serials in the Bolus Herbarium of the South African College. Pp. 54. (Cape Town: South African Public Library.)

In a "Foreword" to this work it is stated that "this list is the outcome of a suggestion first made by Dr. T. Muir, F.R.S., in Nature." The list, which contains the names of about 1100 serials, must be of great service to workers in science in Cape Town; it is arranged in seven columns, the first containing the names of the serials and the remaining six references to the libraries in the following order: South African Library, South African Museum, Royal Observatory, Royal Society of South Africa, Geological Commission, and the South African Association for the Advancement of Science. There is also an appendix containing a list of the serials in the Bolus Herbarium of the South African College.

This arrangement is obviously applicable to cases in which only a small number of libraries are included, but it gives space to indicate the actual volumes which are accessible; thus, in the case of the Smithsonian Annual Reports the six columns have the following entries:—

| 1862–1909 (inc.) [=incomplete] | 1872–1909 (1874 missing) | | 1856– | 1880 1910 | — | 1881–1909 (inc.) |

In the Royal Society's subject indexes, where there are references to nearly thirty British libraries (indicated by symbols), the serials which are incomplete are marked *i*, which gives a very small amount of information and must be regarded merely as a caution.

In the catalogue under notice there is only one case of a serial occurring in all the six libraries, and it is not surprising that this is the Transactions of the Royal Society of South Africa. It is well known that Dr. Muir has inveighed against the multiple sets of the same serials in neighbouring libraries, and has pointed out that it would be better for only one of the libraries to have a complete set of a serial, which would enable some in the vicinity to use their resources in obtaining serials not possessed by others, and his influence in this direction has probably been felt in South Africa.

Union lists of serials have already been prepared in many cities and countries, and we may congratulate the trustees of the South African Public Library in adding to their number.

The Mineralogy of the Rarer Metals: a Handbook for Prospectors. By Edward Cahen and W. O. Wootton, with a foreword by F. W. Harbord. Pp. xxviii+211. (London: Charles Griffin and Co., Ltd., 1912.) Price 6s. net.

This convenient and carefully prepared manual supplies a want that has long been felt. Many of the elementary substances, long regarded as merely chemical curiosities, are now finding useful and often extensive applications in the arts. In the manufacture of filaments for electric lamps, in the preparation of mantles for gas-lighting, in various cases in which hardness or infusibility are desiderata, and especially in the production of steels with special qualities, a large and ever-increasing number of the so-called "rare metals" are finding familiar uses.

The authors in this handy volume have compiled, from the best and latest sources of information, statements of the nature, uses, and properties of these various metals, together with an account of the characters, distribution, methods of detection, and commercial value (where this can be ascertained) of the various minerals which constitute the sources of these rare metals. In view of the ever-increasing demands for many of these metals, and the fact that some which have not yet found useful applications may do so in the future, the appearance of this manual is distinctly opportune. The information, though given in concentrated form, appears to be in nearly every case clear and sufficient; and the book cannot fail to be of very great service to prospectors and others, who are now no longer confined in their researches to seeking for sources of the hitherto limited classes of so-called "precious metals" and "useful metals."

Not the least valuable characteristic of the book is due to the fact that, in its printing and binding, the question of its suitability for being carried in the pocket, for use in the field, has been carefully provided for. Our satisfaction at the appearance of this valuable book is somewhat marred by the information we have received that science has lost a promising worker by the death, since the book was finished, of the author whose name stands second on the title-page. J. W. J.

Education and National Life. By Dr. Henry Dyer. Pp. 112. (London: Blackie and Son, Ltd., 1912.) Price 1s. net.

Dr. Dyer's wide experience of educational affairs in this and other countries should ensure for him many attentive readers. The more important aspects of a question of vital national interest are handled in an inspiring manner, and the essays should prove of value and assistance to professional and business men who have no specialised knowledge of education.

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.]*

Reflection of Röntgen Radiation.

FOLLOWING the investigations of Laue, Friedrich, and Knipping, we were led to study the transmission of a narrow pencil of X-rays through rock salt, a crystal of simple cubic form. The results are of interest, for they show in a striking way a strong reflection from the internal crystallographic planes upon which the pencil fell at nearly grazing incidence. The pencil so reflected is of such intensity that the short exposure required to produce well-marked effects on a photographic plate is insufficient to give more than a trace of the most intense of the other pencils of radiation emerging from the crystal. A small cleaved fragment was placed with one pair of faces horizontal. Below this an X-ray tube was fixed to a stand capable of sliding in grooves along an arc of a vertical circle of which the centre was a point in the crystal and the plane was one of the three principal planes of the crystal. A narrow pencil of X-radiation could then be rotated in this plane approximately about the point of incidence on the crystal.

When the pencil was vertical it was, of course, perpendicular to one face, and parallel to the other two sets of mutually perpendicular principal planes in the crystal. A slight movement of the X-ray tube directed the pencil at nearly grazing incidence on one of the sets of vertical planes. The result was a well-marked spot on the photographic plate situated several centimetres above the crystal, on the same side of these crystallographic planes as the incident pencil. When the latter was made to rotate until it was incident on the other side of these planes, the emergent beam moved through the central direct image to the other side, being again on the same side of the crystallographic planes considered as the incident pencil. The angle turned through by the emerging beam was certainly within a very small possible error the same as that turned through by the incident pencil. We thus have very direct evidence of copious reflection near grazing incidence from cleavage planes within the crystal itself.

This suggested the probability of a similar reflection from the planes of cleavage of mica, and we proceeded to make a concave mirror of mica to test this. A letter from Mr. W. L. Bragg in NATURE of December 12, however, announces that this has just been accomplished. In our experiments with rock-salt the beam enters the crystal in a different manner, but the effect is undoubtedly similar. It is not a pure surface effect, but takes place in the body of the crystal. Whether all the photographic patterns obtainable by experiments like those of Laue, Friedrich, and Knipping are readily explained by reflection, as suggested by Mr. W. L. Bragg, our experiments do not yet permit us to say; but the results of observation of an isolated spot certainly can be accounted for by reflection from a large number of layers of atoms, parallel to one of the pairs of faces of the crystal.

Judging from recent experience we have had of the photographic action of X-rays, it appears probable that a beam reflected in such a way is of sufficient intensity to be detected and followed without any great difficulty by the ionisation method.

C. G. BARKLA.
G. H. MARTYN.

King's College, London, December 14.

Shinobu Hirota.

SHINOBU HIROTA, who returns to Japan at the end of this month, by his doctor's advice, came with me to this country in 1895, and within a week of his arrival the seismograph which he brought with him from Japan was at work at Shide. To convince those who had doubts as to the possibility of recording in Britain earthquakes which had originated even so far away as their antipodes, a second instrument was installed at Carisbrooke Castle. To look after this Hirota had, wet or fine, a daily walk of four miles. The fact that these two instruments gave similar records and also that from a single record we could tell the distance at which a megaseism had originated naturally attracted some attention. Directly it was shown that certain earth disturbances had interrupted cables, Colonies desirous of knowing the cause of these sudden isolations from the rest of the world set up seismographs.

This was the commencement of the British Association cooperation of seismological stations, now sixty in number. To bring this into being Hirota played an active part. He knows personally many of the directors, and has given instruction to their officers. In practical seismometry he has made many innovations, some of which will perhaps be looked upon as "mere dodges," but they have rendered instruments more sensitive. His multiplying levers made of grass stems gathered from "bents" give pointers exactly one-third the weight of their equivalent in aluminium, and yet twice, if not three times, as stiff. It was by using these that we got at Bidston, where Hirota went to set up an instrument, the first records of rock deformation due to tidal load.

In the workshop he is a good all-round workman, in the observatory and office he has kept most careful records, could calculate a chordal distance, make a zenithal projection or an observation for time, while for photographic work he holds a gold medal from the Photographic Society of the Isle of Wight. Above all this, his sharp eyes would find on a seismogram two records where at other stations only one had been discovered. In view of the great attention and large sums which have now been spent, particularly in foreign countries, on the new seismological departure, I feel myself justified in giving recognition to an assistant pioneer in these new studies. Illness carries him back to his native country, where I trust he will have a speedy recovery. His work is embodied in annual seismological reports of the last seventeen years, and twenty-six circulars giving the records received from observatories cooperating with the British Association.

J. MILNE.

Shide, Newport, Isle of Wight.

The Self-testing of Dispersion Apparatus.

A SERIOUS inconvenience attaches to the standard method of testing a plane grating, echelon, or other dispersive apparatus, by crossing its dispersion with that of an auxiliary piece; for, unless the resolving power of the auxiliary dispersion is in some degree comparable with that of the piece to be tested, it is scarcely possible to identify ghosts which lie close to their primaries. When an extended research with crossed dispersions is in question, the case, in most laboratories, becomes even more difficult.

The difficulty, I think, may be removed by means of a simple and relatively inexpensive arrangement of two front-reflecting mirrors, so devised that the echelon (say) is crossed with its own dispersion. One of the mirror faces has one truly straight edge, at which the dihedral angle is 90° or less. This edge is in contact with the face of the second mirror, the two mirrors being adjustably clamped together, so that they can be set exactly at right angles to one another. Now let them be placed so that their line of contact is inclined 45° to the horizon, while (in a roughly approximate sense) the vertical plane through that line of contact bisects *externally* the angle between the mirrors. Vertical lines imaged by successive reflection at the two mirrors will thus appear horizontal, and conversely.

In the case of an echelon grating, the train would bear a general resemblance to a Littrow spectroscope. The light would pass successively through a slit (shortened to a minute square), an objective, and an echelon, and after reflection at the mirrors would return through the echelon and objective, and be brought to a focus in the plane of the slit. For the full advantage of crossed dispersions to be thus realised, it is, of course, essential that the effective aperture of the echelon should be at least as high as it is wide, the width being measured parallel to the dispersion. In echelon gratings and Lummer-Gehrcke plates this generally holds good, though in many gratings the length of the rulings is insufficient for the corresponding condition to be satisfied.

The pair of mirrors described might be replaced by an accurately right-angled prism, with reflecting faces meeting in as sharp and clean a line as possible.

The suggested arrangement may be modified by allowing the beam to pass through a second objective and be brought to a focus in the usual way. A small right-angled prism can then be used to return the beam through the lenses and the echelon between them, and since the intersection of its reflecting faces should lie strictly in the plane of the first formed (singly dispersed) spectrum, it is easy to arrange so that this intersection, as finally viewed, is to one side of the useful field. In this case the prism need not be accurately right-angled, nor indeed is any great demand made on its other optical qualities; it may be some set-off against this that four transmissions through object-glasses are involved.

If an echelon grating of reflecting type is to be crossed with its own dispersion, a method essentially similar to the last-mentioned modification can be used. The apparatus, as arranged for single dispersion, having been auto-collimated, the beam would in the present case be twice brought to a focus, and would in all pass four times through one and the same objective. C. V. BURTON.

Boar's Hill, Oxford, December 7.

Petrifactions of the Earliest European Angiosperms.

UNTIL the three specimens from the English Aptian in the British Museum were recognised as Angiosperms and described in my paper (Phil. Trans. Roy. Soc., series B, vol. cciii., pp. 75–100, plates v–viii, and kindly reviewed in NATURE, August 22, p. 641), Angiosperms were supposed not to have existed in northern Europe at that early date. Those three specimens came from two different localities, which minimised the chances of error, but it is highly satisfactory to have to record the discovery of another specimen from a new locality.

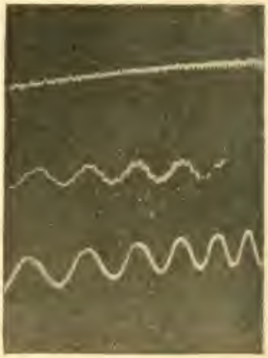
The new specimen is from the Lower Greensand of Kent, and belongs to the Maidstone Museum. While pursuing my study of the Lower Cretaceous flora I recently visited the Maidstone Museum, which has the best extant collection of Lower Greensand fossil plants from Mr. W. H. Bensted's famous Iguanodon Quarry. The collection includes a number of large pieces of silicified wood from other of the numerous quarries in the Lower Greensand in the district. All these I examined carefully, and the majority of pieces proved to be Gymnospermic, but one of the large bits of petrified wood arrested attention. Mr. Allchin, the present curator of the museum, generously allowed me to have sections cut from it, which prove the specimen to be a portion of the trunk of a large woody Angiosperm. A detailed and illustrated account of its anatomy will follow in due course, but it may be remarked here that its general characters differ from those of the three other described species from this horizon, and it certainly represents a new species and possibly a new genus.

As the question of the origin of Angiosperms is one in the forefront of controversy at present, and is one, moreover, about which we have so remarkably little evidence, the discovery of this, which is only the fourth specimen of Aptian Angiosperms yet obtained from northern Europe, is satisfactory in confirming the conclusions reached from the study of the three British Museum specimens. MARIE C. STOPES.

Smoke Trace of Compound Vibrations of Tuning-fork.

I READ with interest the note by Mr. F. H. Parker on upper partials of a tuning-fork, which appeared in NATURE of November 28, p. 361.

As an alternative to taking the first upper partial to be 6·6 times the frequency of the prime, or confirming the relation by separate traces, may I suggest the plan of making a trace of the vibration compounded of the two?



The accompanying print is from one corner of a smoke trace used by me at a popular lecture in 1901. One curve shows the fundamental (128 per second), another the first upper partial, while the centre curve of the three shows the form of vibration executed when the first upper partial is sounding, together with the prime. The three sounds may be heard by the audience, and the smoke traces of each obtained in their presence, and then projected by the lantern. The compound vibration is easily obtained by striking the fork on a hard surface, such as a counter, and so presents no difficulty whatever. The ratio of frequencies of first upper partial and prime for the rather slender fork in question is seen to be of the order 6·25. E. H. BARTON.

University College, Nottingham, December 7.

BREATH FIGURES.

AT intervals during the past year I have tried a good many experiments in the hope of throwing further light upon the origin of these figures, especially those due to the passage of a small blow-pipe flame, or of hot sulphuric acid, across the surface of a glass plate on which, before treatment, the breath deposits evenly. The even deposit consists of a multitude of small lenses easily seen with a hand magnifier. In the track of the flame or sulphuric acid the lenses are larger, often passing into flat masses which, on evaporation, show the usual colours of thin plates. When the glass is seen against a dark ground, and is so held that regularly reflected light does not reach the eye, the general surface shows bright, while the track of the flame or acid is by comparison dark or black. It will be convenient thus to speak of the deposit as bright or dark—descriptive words implying no doubtful hypothesis. The question is what difference in the glass surface determines the two kinds of deposit.

In Aitken's view (Proc. Ed. Soc., p. 94, 1893; Nature, June 15, 1911), the flame acts by the deposit of numerous fine particles constituting nuclei of aqueous condensation, and in like manner he attributes the effect of sulphuric (or hydro-fluoric) acid to a water-attracting residue remaining in spite of washing. On the other hand, I was disposed to refer the dark deposit to a greater degree of freedom from grease or other water-repelling contamination (Nature, May 25, 1911), supposing that a clean surface of glass would everywhere attract moisture. It will be seen that the two views are sharply contrasted.

My first experiments were directed to improving the washing after hot sulphuric or hydrofluoric acid. It soon appeared that rinsing and soaking prolonged over twenty-four hours failed to abolish the dark track; but probably Mr. Aitken would not regard this as at all conclusive. It was more to the point that dilute sulphuric acid (1/10) left no track, even after perfunctory washing. Rather to my surprise, I found that even strong sulphuric acid fails if employed cold. A few drops were poured upon a glass ($\frac{1}{4}$-plate photographic from which the film had been removed), and caused to form an elongated pool, say, half an inch wide. After standing level for about five minutes—longer than the time required for the treatment with hot acid—the plate was rapidly washed under the tap, soaked for a few minutes, and finally rinsed with distilled water, and dried over a spirit lamp. Examined when cold by breathing, the plate showed, indeed, the form of the pool, but mainly by the darkness of the *edge*. The interior was, perhaps, not quite indistinguishable from the ground on which the acid had not acted, but there was no approach to darkness. This experiment may, I suppose, be taken to prove that the action of the hot acid is not attributable to a residue remaining after the washing.

I have not found any other treatment which will produce a dark track without the aid of heat. Chromic acid, *aqua regia*, and strong potash are alike ineffective. These reagents do undoubtedly exercise a cleansing action, so that the result is not entirely in favour of the grease theory as ordinarily understood.

My son, Hon. R. J. Strutt, tried for me an experiment in which part of an ordinarily cleaned glass was exposed for three hours to a stream of strongly ozonised oxygen, the remainder being protected. On examination with the breath, the difference between the protected and unprotected parts was scarcely visible.

It has been mentioned that the edges of pools of strong cold sulphuric acid and of many other reagents impress themselves, even when there is little or no effect in the interior. To exhibit this action at its best, it is well to employ a minimum of liquid; otherwise a creeping of the edge during the time of contact may somewhat obscure it. The experiment succeeds about equally well even when distilled water from a wash-bottle is substituted for powerful reagents. On the grease theory the effect may be attributed to the cleansing action of a pure free surface, but other interpretations probably could be suggested.

Very dark deposits, showing under suitable illumination the colours of thin plates, may be obtained on freshly-blown bulbs of soft glass. It is convenient to fill the interior with water, to which a little ink may be added. From this observation no particular conclusion can be deduced, since the surface, though doubtless very clean, has been exposed to the blow-pipe flame. In my former communication, I mentioned that no satisfactory result was obtained when a glass plate was strongly heated *on the back* by a long Bunsen burner; but I am now able to bring forward a more successful experiment.

A test-tube of thin glass, about $\frac{1}{2}$ inch in diameter, was cleaned internally until it gave an even bright deposit. The breath is introduced through a tube of smaller diameter, previously warmed slightly with the hand. The closed end of the test-tube was then heated in a gas flame urged with a foot blow-pipe until there were signs of incipient softening. After cooling, the breath deposit showed interesting features, best brought out by transmitted light under a magnifier. The greater part of the length showed, as before, the usual fine dew. As the closed end was approached the drops became gradually larger, until at about an inch from the end they disappeared, leaving the glass covered with a nearly uniform film. One advantage of the tube is that evaporation of dew, once formed, is slow, unless promoted by suction through the mouth-tube. As the film evaporated, the colours of thin plates were seen by reflected light. Since it is certain that the flame had no access to the internal surface, it seems proved that dark deposits can be obtained on surfaces treated by heat alone.

In some respects a tube of thin glass, open at *both* ends, is more convenient than the test-tube. It is easier to clean, and no auxiliary tube is required to introduce or abstract moisture. I have used one of 3/10 in. diameter. Heated locally over a simple spirit flame to a point *short of softening*, it exhibited similar effects. This easy experiment may be recommended to anyone interested in the subject.

One of the things that I have always felt as a difficulty is the comparative permanence of the dark tracts. On flat plates they may survive in some degree rubbing by the finger, with subsequent rinsing and wiping. Practically the easiest way to bring a plate back to its original condition is to rub it with soapy water. But even this does not fully succeed with the test-tube, probably on account of the less effective rubbing and wiping near the closed end. But what exactly is involved in rubbing and wiping? I ventured to suggest before that possibly grease may penetrate the glass somewhat. From such a situation it might not easily be removed, or, on the other hand, introduced.

There is another form of experiment from which I had hoped to reap decisive results. The interior of a mass of glass cannot be supposed to be greasy, so that a surface freshly obtained by fracture should be clean, and give the dark deposit. One difficulty is that the character of the deposit on the irregular surface is not so easily judged. My first trial on a piece of plate glass $\frac{3}{8}$ in. thick, broken into two pieces with a hammer, gave anomalous results. On part of each new surface the breath was deposited in thin laminæ capable of showing colours, but on another part the water masses were decidedly smaller, and the deposit could scarcely be classified as black. The black and less black parts of the two surfaces were those which had been contiguous before fracture. That there should be a well-marked difference in this respect between parts both inside a rather small piece of glass is very surprising. I have not again met with this anomaly; but further trials on thick glass have revealed deposits which may be considered dark, though I was not always satisfied that they were so dark as those obtained on flat surfaces with the blow-pipe or hot sulphuric acid. Similar experiments with similar results may be made upon the edges of ordinary glass plates (such as are used in photography), cut with a diamond. The breath deposit is best held pretty close to a candle-flame, and is examined with a magnifier.

In conclusion, I may refer to two other related matters in which my experience differs from that of Mr. Aitken. He mentions that with an alcohol flame he "could only succeed in getting very slight indications of any action." I do not at all understand this, as I have nearly always used an alcohol flame (with a mouth blow-pipe) and got black deposits. Thinking that perhaps the alcohol which I generally use was contaminated, I replaced it by pure alcohol, but without any perceptible difference in the results.

Again, I had instanced the visibility of a gas flame through a dewed plate as proving that part of the surface was uncovered. I have improved the experiment by using a curved tube through which to blow upon a glass plate already in position between the flame and the eye. I have not been able to find that the flame becomes invisible (with a well-defined outline) at any stage of the deposition of dew. Mr. Aitken mentions results pointing in the opposite direction. Doubtless, the highly localised light of the flame is favourable.

RAYLEIGH.

PALÆOLITHIC MAN.

THE fossil human skull and mandible to be described by Mr. Charles Dawson and Dr. Smith Woodward at the Geological Society as we go to press is the most important discovery of its kind hitherto made in England. The specimen was found in circumstances which seem to leave no doubt as to its geological age, and the characters it shows are themselves sufficient to denote its extreme antiquity. It was met with in a gravel which was deposited by the river Ouse near Piltdown Common, Fletching, Sussex, at a time when that river flowed at a level eighty feet above its present course.

Although the basin of the stream is now well within the Weald and far removed from the chalk, the gravel consists largely of iron-stained flints closely resembling those well known in gravel deposits on the downs, and among these there are many waterworn "eoliths" identical with those found on the chalk plateau near Ightham, Kent.

With the flints were discovered two fragments of the molar tooth of a Pliocene elephant, and a waterworn cusp of the molar of a Mastodon. The gravel is therefore partly made up of the remains of a Pliocene land-deposit. Teeth of hippopotamus, beaver, and horse, and part of the antler of a red deer were also found, with several unabraded typical early Palæolithic (Chellean) implements. The latter seem to determine the age of the gravel as Lower Pleistocene.

The human remains, which are in the same mineralised condition as the associated fragments of other mammals, comprise the greater part of the brain-case and one mandibular ramus which lacks the upper portion of the symphysis. The skull measures 190 mm. in length by 150 mm. in width at its widest part, and the bones are of nearly twice the normal thickness. Its brain capacity is about 1070 c.c. The forehead is much steeper than in the Neanderthal type, with only a feeble brow-ridge; and the back of the skull is remarkably low and broad, indicating an ape-shaped neck. The mandible, so far as preserved, is identical in form with that of a young chimpanzee, showing even the characteristically simian inwardly curved flange of bone at the lower border of the retreating symphysis. The two molars preserved are of the human pattern, but comparatively long and narrow.

At least one very low type of man with a high forehead was therefore in existence in western Europe long before the low-browed Neanderthal man became widely spread in this region. Dr. Smith Woodward accordingly inclines to the theory that the Neanderthal race was a degenerate offshoot of early man and probably became extinct, while surviving modern man may have arisen directly from the primitive source of which the Piltdown skull provides the first discovered evidence.

DR. C. THEODORE WILLIAMS, M.V.O.

WE record with regret the death of Dr. Charles Theodore Williams, on December 15, at the age of seventy-four years. He was the second son of Dr C. J. B. Williams, F.R.S., physician to University College Hospital and consulting physician to the Brompton Hospital. He was educated at Harrow and Pembroke College, Oxford, and afterwards studied medicine at St. George's Hospital and in Paris. He took the degree of M.A. in 1862, M.B. in 1864, and M.D. in 1869. In 1867 he was appointed assistant physician to the Brompton Hospital, and became full physician in 1871 and consulting physician in 1894.

Dr. Theodore Williams became a member of the Royal College of Physicians in 1865, and was elected a fellow in 1871, councillor 1891–93, and censor 1899–1900. He was an honorary fellow of Pembroke College, Oxford, and a member of the Athenæum Club. He was an active member of nearly all the London medical societies, and was president at various times of several of them. He was twice president of the Royal Meteorological Society. He was an honorary member of the Société Française d'Hygiène and of the American Climatological Society. He had the distinction of being elected one of the four presidents of the International Congress on Tuberculosis, held at Washington, the others being Koch, Landouzy, and Trudeau.

Dr. Theodore Williams had a large practice as a physician and a high reputation as a specialist in consumption, in which he had a very wide and varied experience. In collaboration with his father, he was the author of a work entitled "Pulmonary Consumption: its Modes of Arrest, Treatment and Duration," 1871. A second edition, revised and enlarged, being mainly rewritten by Dr. Theodore Williams, was published in 1887.

Dr. Theodore Williams was specially interested in the effects of climate in the treatment of pulmonary disease, and his first book, on the "Climate of the South of France," was published in 1867, when comparatively little was known of the Riviera as a health resort. In 1869 he visited Davos and examined many cases there, and reported very favourably on the results obtained by residence in the high altitudes. Later he incorporated his observations in his lectures on aerotherapeutics delivered before the Royal College of Physicians, 1893.

In 1911 he delivered the Harveian Oration before the Royal College of Physicians, choosing as his subject "Old and New Views on the Treatment of Consumption."

Dr. Theodore Williams was an active worker in the cause of prevention of consumption, and was one of the founders of the National Association, of which at the time of his death he was vice-chairman of the Council. He was one of the founders of the Queen Alexandra Sanatorium at Davos, and one of the most active workers in the establishment of the Brompton Sanatorium at Frimley and the King Edward VII. Sanatorium at Midhurst. For his work in connection with the latter, King Edward gave him the honour of the M.V.O.

He contributed many papers to the transactions of the medical societies and to the medical journals. In 1868 he married Mary, daughter of Dr. John Gwyn Jeffreys, F.R.S., a well-known authority on conchology. He is survived by his wife, whose bereavement has called forth general sympathy.

NOTES.

INFORMATION has been received at the Meteorological Office that the first prize of 2000 marks in the competition recently organised by the German Meteorological Society for the best discussion of the results of the international investigation of the upper air has been awarded to Mr. Ernest Gold, superintendent of statistics at the office, for his essay, entitled "The International Kite and Balloon Ascents."

MR. C. J. GAHAN, first class assistant in the department of zoology of the British Museum (Natural History), has been appointed to the newly created post of keeper of the department of entomology. Hitherto, for administrative purposes, there has been an entomological section of the department of zoology; in future there will be a special department of entomology under its own keeper.

PROF. JACQUES HADAMARD, professor of analytical and celestial mechanics at the Collège de France, and professor of mathematical analysis at the École Polytechnique, Paris, has been elected a member of the Paris Academy of Sciences in the section of geometry, in succession to the late Prof. Henri Poincaré.

THE death is announced, in his seventy-second year, of Mr. A. Beldam, first president of the Institute of Marine Engineers.

DR. WILLIAM J. HOWARTH, medical officer of the county of Kent, has been appointed medical officer of the City of London in succession to Dr. William Collingridge, who recently retired.

MR. E. J. LOOMIS, for fifty years an assistant in the American Nautical Almanack Office, died recently in Washington at the age of eighty-four. In 1889 he was a member of the United States eclipse expedition to the west coast of Africa. The list of his publications includes "Wayside Sketches," "An Eclipse Party in Africa," and "A Sunset Idyll and Other Poems." Mr. Loomis was the father of Mrs. Mabel Loomis Todd, who has collaborated with her husband, Prof. David Todd, of Amherst, in much of his astronomical work.

THE death is reported, in his sixty-second year, of Mr. Edwin Smith, an American astronomer and geodesist of repute. He had spent the greater part of his career in the service of the United States Coast and Geodetic Survey. In 1874 he was placed in charge of the United States Government expedition to observe the transit of Venus at Chatham Islands, in the South Pacific, and in 1882 he was entrusted with a similar task at Auckland, N.Z. Later, he determined the force of gravity at Auckland, Sydney, Singapore, Tokyo, San Francisco, and Washington, by means of the three Kater pendulums of the Royal Society. He was a member of several scientific societies, and was one of the founders of the Cosmos Club at Washington.

We are informed by the senior member of the department of botany at the Pennsylvania State College that Dr. William A. Buckhout, professor of botany and the senior professor at the college, died of heart disease on December 3. Dr. Buckhout was born in December, 1846, and was graduated from the Pennsylvania State College in 1868. In 1871 he became professor of botany and horticulture at that college. In the changes brought about in agricultural sciences during recent years he became professor of botany. For many years he was botanist of the Pennsylvania State Board of Agriculture. In 1888 he was appointed to the Pennsylvania State Forestry Commission, and was a prime mover in the State in creating and taking an active interest in forestry. He was author of papers on the chestnut as a fruit and food, the effect of smoke and gas on vegetation, a microscopic examination of State College water supply, forest fires, and others, and also of annual reports as State botanist.

We gather from the report of the ninth season during which the Brent Valley Bird Sanctuary has been maintained, that the season 1912 was very successful. Nightingales bred as before; blackcap warblers increased largely in number; a nest of the marsh tit made a new record; and young wrynecks were reared for the first time. The work of the committee is spreading all over the country; the new nesting boxes, made from logs, which open at the top, are being very generally used, and a number of bird-lovers have found that they and feeding tables make excellent Christmas presents. The honorary secretary is Mrs. Wilfred Mark Webb, of Odstock, Hanwell, London, W.

The fourth part of the Proceedings for 1912 of the Institute of Chemistry gives particulars of the progress which is being made towards the provision of new buildings for the institute. At an extraordinary general meeting of the institute, held on November 14 last, two resolutions were carried unanimously. One empowered the council to acquire from the Bedford Estate the site of 30 Russell Square, London, for a term of ninety-nine years, at a ground rent not exceeding 300*l.* per annum, one year at peppercorn rent. The other resolution gave the council power to apply the building fund and all future contributions to it to the erection and equipment of suitable buildings. The council finds that the original estimate of 15,000*l.* for the buildings will not allow of any undue elaboration in construction, or leave more than sufficient margin for adequate equipment. Of the 15,000*l.* required, 3932*l.* has still to be found. We notice, also, that the Public Appointments Committee of the institute has had under consideration the conditions attaching to chemical appointments under the Civil Service, and finds in some instances that the status of chemists employed is far from satisfactory. The Royal Commission on the Civil Service has invited the council to forward a statement for consideration.

The International Congress of Medicine is to be held in London next August. It is expected that some 5000 medical men will be present as delegates. The congress assembles once in every four years, and is received in turn in all the capitals of Europe. It was last held in 1909 in Budapest. The congress will be presided over by Sir Thomas Barlow, president of the Royal College of Physicians. The general addresses to the full congress in the Albert Hall will be given by Prof. Chauffard, of Paris, on medicine; Prof. Paul Ehrlich, of Frankfurt, on pathology; Mr. John Burns, M.P., on public health; Prof. Harvey Cushing, of Harvard University, on surgery; and Mr. W. Bateson, F.R.S., on heredity. The subjects for discussion are mostly of professional interest, but some make a wider appeal, such as the psychology of crime, to be considered at a joint meeting of the Forensic Medicine and Psychiatry Sections. The causes of epidemic diseases and the effects of dust in producing diseases of the lungs are to be considered in the Section of Hygiene, the Forensic Medicine Section will discuss the causes and prevention of suicide, and the Tropical Medicine Section the subjects of plague and beri-beri.

We have been favoured with a reprint of an article from *The Halifax Guardian* of November 30 in which Mr. W. B. Crump records his personal connection with the Belle Vue Museum, Halifax, and expresses his opinion on the present state and future prospects of that institution. The function of the museum, it appears, is considered to be educational, and the collections are therefore to a great extent of a general rather than a local character, but special attention is directed to certain slides prepared from the coal-balls of Beacon Hill, which are stated to have largely contributed, in the hands of Messrs. Williamson, Scott, and Spencer, to our knowledge of the mode of formation of the Coal Measures.

Vol. VIII. of the Records of the Indian Museum, the first part of which has just come to hand, is to be devoted to the zoological results of the Abor expedition of 1911–12. Mr. Stanley Kemp, it will be remembered, accompanied the expedition as naturalist, and it is his collections which form the subject of the volume. In the present issue Dr. Nelson Annandale describes eight tailless amphibians, three snakes, and one lizard as new. A considerable proportion of the amphibians were in the larval stage, and it is noticeable that many of the tadpoles, like those of the Darjiling district, possess special adaptations to prevent their being carried away by the strong currents of the streams they inhabit. Dr. Annandale also contributes an account of the few Porifera (sponges) obtained, while Captain W. H. Evans does the same for the Lepidoptera, Mr. F. H. Gravely for the Scolopendridæ, and Mr. C. A. Paiva for the Hymenoptera Anthophila (bees, wasps, &c.).

The November number of *The American Museum Journal* contains a beautifully illustrated article by Mr. G. B. Sudworth on the present condition of the big-trees (Sequoia) of California. Thirty-one groups of these trees, covering areas ranging from less than an acre to ten square miles, and collectively occupying about fifty square miles, are known. Some of these tracts are in private hands, while others belong to the Federal Government, and it is urged that the splendid grove in North Calaveras should be acquired by Government. In the groves belonging to Government no felling, except when absolutely necessary, is permitted, but in those in private hands "lumbering" is carried on to a greater or less extent. The great danger to these trees is fire. The opinion has been expressed that the Sequoias are not reproducing themselves, and it seems that the seeds will not germinate in ground thickly covered with vegetable débris, or in deep shade. It is stated, however, that "wherever in the southern groves lumbering and fire have opened up the forest and exposed the mineral earth, an abundance of young big-trees is always found near seed-trees, unless, of course, fire has destroyed them."

Prof. H. Molisch has revised and enlarged his well-known work on luminosity in plants ("Leuchtende Pflanzen," Gustav Fischer, Jena, price 7.50 marks). Since the publication of the first edition (reviewed in Nature, November 23, 1905) various writers—notably Prof. Molisch himself—have contributed to this interesting branch of plant physiology, and these scattered contributions are now brought together, with references to the literature of the subject. A large portion of the work is devoted to the phenomena of luminosity due to bacteria and fungi, though the various "phosphorescent" phenomena observed in animals and in the higher plants are discussed. Molisch concludes that the luminosity of plants (from which, of course, are excluded various cases of luminescence due to reflection of light brought to a focus by lens-shaped cells, and the like) is due to the production in the living cell of a substance ("photogen") which becomes luminous in the presence of water and free oxygen, and that this substance is either a protein or a phosphatid. The luminosity of the luminous bacteria and fungi differs from the various phosphorescent phenomena in animals in that the light is continuous during life, and not intermittent, though it may be due in all cases to a similar cause—the oxidation of photogenic substances by means of oxidising ferments.

The Journal of Agricultural Science (vol v., part 1) contains, amongst others, a paper by Mr. W. A. Davis on the estimation of potassium in fertilisers, soil extracts and plant ashes. It is shown that the perchlorate method, of which a modification is suggested, yields more accurate results than that in which platinum chloride is used, and has the additional advantages of (*a*) being more economical; (*b*) the results are not affected by the presence of barium, calcium, and magnesium chlorides and sodium phosphate; and (*c*) all uncertainty such as exists as to what value shall be taken for the atomic weight of platinum is avoided.

In addition to the useful latest reports of ice given in the monthly meteorological charts of the North Atlantic Ocean issued by the Deutsche Seewarte, that for December contains the commencement of a series of air and sea temperature observations extracted from the log-books of Transatlantic steamers in the region of drift ice. The extracts, arranged according to groups, include (1) observations of great fluctuations of temperature; (2) ice encountered without much change of temperature; (3) great decrease of temperature indicating proximity of ice. During 1912 more than ordinary attention has been directed to the danger of ice, owing to the unusual extension of its distribution and to its density. In the case of fog the only means of detecting ice, in addition to a more careful outlook, is the observation of air and sea temperature, but it has been shown that such data are at times untrustworthy. The collection and publication of these extracts are, we consider with the Seewarte, of considerable utility, as affording data for a careful examination of the behaviour of temperature in the drift-ice region, independently of whether or not ice was actually met with.

The report of the census of the island of Mauritius and its dependencies for 1911 has just been received. The population is practically stationary as compared with 1901, the slight decrease in the case of the main island being balanced by an almost equivalent increase in the dependencies. About 29 per cent. of the population are included under the term "general population," about 1 per cent. are Chinese, and the rest are included as Indo-Mauritians or other Indians; the latter class includes Indians born out of the colony, whom it is becoming increasingly difficult to distinguish from Indo-Mauritians. Fewer people are returned as engaged in industrial occupations; there has been an increase in the males who are agriculturists, and in the females who are domestics, but a decrease in the male domestics, in the general population, while the Indian population has become more definitely commercial and industrial at the expense of agriculture and domestic service. The report includes a map on the scale 1 in. = 1 mile, showing the geographical distribution of the people. The Census Commissioner has also published a study in Mauritian statistics which deals with "agricultural labour." This study necessarily refers almost exclusively to the sugar industry, and points out that the position of the Indian labourer is "one of unusual prosperity," since labour is scarce; sugar yields are abnormally high, and prices are remunerative.

A summary of the agricultural statistics for British India for the quinquennium ending with the season 1910–11 has just been issued by the Indian Government. The percentages of the area of British India for this and the preceding quinquennium show an approximately constant subdivision as follows:—Forest, 13 per cent.; not available for cultivation, 25 per cent.; culturable waste, 19 per cent.; current fallow, 7 per cent.; net area cropped, 36 per cent. Roughly 17 per cent. of the cropped area, which is sometimes cropped twice, is irrigated. About 90 per cent. of the cropped area is constantly devoted to food grains, and includes 35 per cent. to rice, 10 per cent. to wheat. The acreage devoted to cane-sugar has remained steady at 1 per cent., but that devoted to cotton, which is about one-twentieth of the cropped area, shows an increase for the last quinquennium as compared with that which preceded it. Indigo culture has steadily declined during the ten years, until the acreage in the last season was but one-third of the acreage ten years previously; this decline has been most marked during the last five years in Madras, and least marked in Bengal. The acreage given up to opium has declined also within the five years to about two-thirds of that of the earlier period. The acreage devoted to coffee is also smaller, and those given up to tea and tobacco have been increased. Tables are given regarding the average yield per acre of certain crops in certain districts; these show that irrigated land gives an increased yield over unirrigated land for rice in Madras (20 per cent.), Punjab (40 per cent.), and for wheat in the United Provinces (45 per cent.), and in Bombay (100 per cent.).

WHEN ultra-violet light falls on an electro-positive metal, the metal emits negative electrons, and the phenomenon has received the name of the photo-electric effect. Two theories as to the mechanism by which the effect is brought about have been suggested at various times. The first regards the electrons of the metal as in harmonic oscillation and ascribes the emission to resonance due to the light frequency; the other, and in some respects the better, takes them as describing elliptic orbits like planets and regards the emission as due to conversion of the orbits into parabolas owing to the absorption of light. In the *Verhandlungen* of the German Physical Society for October 30, Dr. K. Herrmann shows that neither theory is in itself altogether satisfactory, and concludes that in all probability both causes are at work, resonance in the case of the selective effect, and the other in the normal effect.

A PAPER by Prof. Luigi Palazzo, extracted from vol. xxxii., part i., of the *Annali dell' Ufficio Centrale di Meteorologia e Geodinamica*, deals with magnetic observations made in 1908 and 1909 by Prof. Palazzo himself, and in 1907 to 1909 by an Italian surveying vessel, along the coast of Italian Somaliland and British East Africa. It includes a magnetic chart for the epoch January 1, 1909, giving lines of equal declination, inclination, and horizontal force for the coastal district from 6° N. latitude to a little south of the equator. The chart and an abbreviated account of the observational material also appear in monograph No. 17 relating to colonial affairs, published in September, 1912, by the Italian Foreign Office. In a preface to No. 4 of these same monographs, Prof. Palazzo advocates the establishment of a magnetic observatory in Tripoli. This proposal, he says, met with considerable encouragement at a meeting of the International Magnetic Commission, held in 1910, in Berlin, and recent political events would seem to favour its realisation.

MESSRS. BURROUGHS, WELLCOME AND CO. have sent us the 1913 edition of their photographic exposure record and diary, which is, as usual, neat and handy. There are many photographers to whom this little pocket-book is most necessary, and they will no doubt be glad to hear of this early issue, for does it not comprise a useful gift to a photographic friend? The concentrated and high standard of excellence of the contents of this diary in former years does not leave much room for any great additions or alterations in the present issue, but where possible, such as in the tables of film plate and paper speeds, the most recent data have been inserted. The pocket-book, as usual, includes that excellent and easily worked exposure calculator which may be regarded as the main feature of the issue, a feature of great value to those who are acquainted with it. Three separate diaries are issued, namely for the northern hemisphere and tropics, southern hemisphere and tropics, and for the United States of America, and all are got up in their tasteful style for the reasonable sum of 1*s*.

UNDER the title "Kreislaufvorgänge in der Erdgeschichte," Mr. Gustav Fischer, of Jena, has published (price 1.50 marks, pp. 39) an address by Prof. Gottlob Linck delivered before the University of Jena in June last. It is an interesting review, based on the most recent results, of the probable course of the formation of the earth and its atmosphere, dealing more particularly with the reasons for the present proportion of oxygen and nitrogen in the air, the composition of sea-water, and the origin of limestone rocks. The principal cyclic changes, both organic and inorganic, which occur under present terrestrial conditions are discussed, and a prophetic glance thrown on the future course of the world's history. Although the subject is highly speculative, it is treated with due regard to quantitative calculation and the most trustworthy geochemical data are employed. One noteworthy suggestion put forward is that by the progressive oxidation of the ferrous iron in the eruptive rocks the atmosphere will be gradually depleted of its oxygen, until insufficient remains to support the present existing forms of life.

A RIFLE-BARREL is very sensitive to transverse stress, and vibrations are produced in it by the explosion of the charge, by the friction between the bullet and the barrel, and by the reaction between the bullet and the rifling. Mr. Francis Carnegie has read a paper at the Institution of Civil Engineers on December 3 giving an account of his experiments on these vibrations and drawing conclusions therefrom. In the case of a 0·303 in. Mark III. Lee-Enfield rifle, the natural vibration of the barrel was first found by removing all its attachments. The attachments were then added one after another and the effect of each on the vibrations examined by photographic means. The position on the vibration curve at which the bullet leaves the muzzle is discussed, and the author favours the point of maximum displacement, as being likely to obtain a much less scattered group on the target. Experiments were also made with different designs of barrel, and it was found that the exterior shape of the barrel materially affected the vibrations. Experiments with different pitches of rifling indicate marked effects on the vibrations, but the results do not establish definite conclusions. The nature of breeching-up of barrel and body, whether abnormally tight or loose, makes a considerable difference; correct breeching-up must be enforced if regular and consistent shooting is to be maintained. Alterations in the muzzle velocity make but little difference in the general characteristic of the vibration curve for any given rifle.

WITH reference to the American milk depôts or stations mentioned in the article on tuberculosis and the milk supply in NATURE of November 7 (p. 281), Mr. Wilfred Buckley writes to point out that the milk supplied is not certified milk in the sense in which the term is here understood, but is an "inspected" or "controlled" milk, which can be delivered at these stations at a cost of about 5*d*. per English quart.

THE Cambridge University Press has recently taken over the publication of *The Biochemical Journal*, which has now become the property and the official organ of the Biochemical Society. The journal, which will be isued from six to eight times a year, will be under the editorship of Prof. W. M. Bayliss, F.R.S., and Dr. A. Harden, F.R.S.

THE Royal Insurance Company, Ltd., of Liverpool, has issued a sixth edition of its handy little publication, "Rules of Golf." The rules as now printed were approved by the Royal and Ancient Golf Club of St. Andrews at its autumn meeting on September 24 last. The alterations of rules and the new features decided upon at that meeting are clearly set out. The manager of the Royal Insurance Company will, so long as the stock lasts, forward a copy of the book free on application.

MESSRS. E. T. NEWTON AND SON, LTD., of Camborne, Cornwall, have issued a new list of scientific and mathematical instruments manufactured by them. Special attention is devoted to instruments required by the surveyor in the various branches of his work, and the catalogue provides well-illustrated particulars of a variety of patterns of theodolites and accessories.

MESSRS. J. M. DENT AND SONS, LTD., have added to their series of scientific primers, published at the price of 1*s*. net, one on astronomy, by the Astronomer Royal, Dr. F. W. Dyson, F.R.S. This primer is a condensation of Dr. Dyson's "Astronomy: a Handy Manual for Students and Others," which was reviewed in our issue for September 29, 1910 (vol lxxxiv., p. 393). It is devoted almost entirely to the bodies in the solar system, the chapter devoted to the stars occupying only six pages.

HAZELL'S Annual for 1913 is the twenty-eighth issue of this useful and handy work of reference, which deals with everyday topics and activities. An interesting section of the book is called "The March of Science," and provides a brief account of the Dundee meeting of the British Association, condensed summaries of the work done and progress made in the various branches of science, short descriptions of recent great engineering schemes and of aërial navigation in 1912, as well as particulars of the various scientific societies.

OUR ASTRONOMICAL COLUMN.

SUN-SPOTS.—During the past week a large group of sun-spots has been visible on the solar disc. First seen on the eastern limb on December 12, the group was nearly central on December 17, its length being about one-tenth of the solar diameter; on the latter date a second, smaller group appeared in the N.W. quadrant.

THE INTERNATIONAL TIME CONFERENCE.—This important conference, referred to in our issue of October 31, duly met at the Paris Observatory, under the presidency of M. Bigourdan, and was divided into four separate commissions, each charged with the discussion of an important group of questions affecting the general problem.

From *The Observatory* (No. 455) we learn that, among other points, the conference agreed to use Greenwich time universally, to send out signals at exact hours, and to arrange that there shall be no overlapping; an agreement as to the most suitable wave-length to employ in the transmission of the signals by wireless telegraphy was also arrived at.

The States represented at the conference were Austria, Belgium, Brazil, France, Great Britain, Greece, Holland, Italy, Monaco, Portugal, Russia, Spain, Sweden, Switzerland, and the United States, and it is to be proposed to them that a "Commission Internationale de l'Heure," with an executive bureau in Paris, shall be established. Among other functions the bureau will endeavour to secure uniformity at the different stations, and will compare the various signals received with the object of improving their general accuracy. Nine "sending" stations, distributed round the globe, have been selected, and the times for each to send out its signals have been arranged; it is proposed to inaugurate the general scheme on July 1, 1913. The question of the perturbation of radiotelegraphic signals by atmospheric agents is, we learn, to be especially studied at a powerful station now being constructed at Laeken.

ELEMENTS AND EPHEMERIS FOR COMET 1912*c* (BORRELLY).—From recent observations made by Prof. Strömgren, a corrected set of elements for comet 1912*c* has been calculated by Prof. Kobold, and is published, with a daily ephemeris extending to January 6, 1913, in No. 4616 of the *Astronomische Nachrichten*. According to the ephemeris the comet is now (December 19) some 8′ east of β Aquarii, and is moving slowly in a direction east of south. Its calculated magnitude is 10·4, but Prof. Strömgren's observations show it to be extraordinarily faint; the following is an extract from the ephemeris:—

Ephemeris for 12h. (M.T. Berlin).

1912	α h. m.	δ ° ′	log r	log Δ	Mag.
Dec. 21	20 34·7	−6 35·1	0·1693	0·3160	10·4
25	20 40·8	−7 55·4	0·1811	0·3363	10·6
29	20 46·6	−9 6·8	0·1928	0·3550	10·7

THE INFLUENCE OF SPECTRUM ANALYSIS ON COSMICAL PROBLEMS.—A very interesting lecture, by Prof. Max Wolf, on the influence that spectrum analysis has exercised in the solution of cosmical problems is reprinted in an abstract from the *Zeitschrift für Elektrochemie*, No. 12.

The subjects briefly discussed by Prof. Wolf are far too numerous even to mention here, but they include the cosmical application of the Doppler and Zeeman effects, the determination of the gaseous character of some nebulæ by Huggins, the Lockyer-Janssen daylight observation of prominences in 1868, the progressive successes of Hale and Deslandres in the photography of the sun's upper atmospheric layers while the sun is not eclipsed, the observation of the helium (D_3) line in the chromosphere by Lockyer, twenty-five years before the element was discovered terrestrially, and even the very recent work of Dr. Nicholson in the theoretical construction of such spectra as those of the unknown cosmical elements nebulium and coronium. This brief enumeration will serve to show that Dr. Wolf's paper is not only comprehensive, but also up to date, and should be read by all interested in astrophysics.

ELEMENTS OF RECENTLY DISCOVERED MINOR PLANETS.—In No. 4607 of the *Astronomische Nachrichten*, Dr. Cohn gives the elements and permanent numbers of eighteen minor planets discovered during 1911–12. Four of these have been identified with older discoveries to which no numbers had been allotted, and eleven of the "discoveries" made during 1911 have since been identified with planets previously included in the official records. The total number thus included, as shown by the present list, is 732.

THE PHYSICAL SOCIETY'S EXHIBITION.

THE eighth annual exhibition of physical apparatus under the auspices of the Physical Society of London was held on Tuesday, December 17, at the Imperial College of Science, and attracted the usual large attendance. At both the afternoon and evening sessions a short discourse was given by Mr. S. G. Brown on "Some Methods of Magnifying Feeble Signalling Currents." The lecturer described several instruments designed by himself for magnifying the currents received through Atlantic cables, by the use of which largely increased speed of signalling had been made possible. The most interesting of these was one in which the original signalling current moves a thermo-electric junction into and out of a small flame, the thermo-electric current thus produced being twenty-seven times that of the signalling current. The magnifying power is approximately constant for all currents, an advantage over the ordinary form of relay in which the current of the local circuit is constant and is merely made or broken by the signalling current. Other mechanical methods of achieving the same result were also described.

Exhibits of apparatus were shown by some thirty firms of manufacturers. The principal exhibit of the Cambridge Scientific Instrument Co. was a complete cardiograph outfit, composed of an Einthoven string galvanometer, projection apparatus, camera with moving plate or continuous paper for cases where long records are necessary, and a switchboard by which the standardisation of the galvanometer, compensation for skin currents, and measurements of body resistance could be quickly made. By an auxiliary apparatus, records of the heart sounds could also be obtained. Another of their exhibits was a Wilson cloud apparatus for showing the path of α particles or X rays by the condensation of water upon the ions. Messrs. J. J. Griffin and Sons had an interesting exhibition of motor-gyrostats with models for illustrating the Schlick method of steadying ships, and the gyrostatic mono-rail car. Mr. C. V. Boys's rainbow cup for showing the colours of thin films was also exhibited in action. In addition to the usual laboratory instruments, Messrs. Gambrell Bros. exhibited a new convection radiometer by Mr. F. W. Jordon for measuring small, steady rates of evolution or absorption of heat. The convection current of gas produced by the source of heat deflects two very light suspended mica vanes, the deflection being shown in the usual way by a mirror. The Marconi Co. exhibited instruments for use in wireless telegraphy, including a portable knapsack receiving and transmitting set for communicating across distances of fifteen miles. The Helsby Wireless Telegraph Co. showed a vibration-proof detector and a rotary quenched spark discharger.

Microscopes for ultra-microscopic and for metallurgical work were exhibited by Messrs. R. and J. Beck, Messrs. E. Leitz, and Messrs. Carl Zeiss. The last firm also had an example of its projection apparatus at work. The principal exhibits of Messrs. Alexander Wright and Co. consisted of various forms of Dr. Leonard Levy's apparatus for the examination of mine air according to the provisions of the Coal Mines Act of 1911. They also exhibited some good examples of palladium and platinum plating on metals and gold plating on glass.

Messrs. Kelvin and James White, Ltd., exhibited a compass for use on aeroplanes. It was of the floating type, and said to be entirely unaffected by the vibrations of the engines. A Fullarton vibrometer for obtaining the frequency and intensity of vibrations produced by any form of machinery was also shown. It consists of a vibrating reed which can be adjusted to the frequency of the vibration to be measured, the intensity being shown by the amplitude of the vibration of the reed. An Aitken portable dust counter for quickly estimating the number of dust particles in the air, based on the method of condensation of moisture on them, was exhibited by the same firm. Mr. R. W. Paul had a large exhibit of electrical measuring instruments, including several new types. Among them was a string galvanometer somewhat similar to the Einthoven, but with the string in a horizontal position. The Irwin optiphone was shown in use. This is an instrument for magnifying the motion of a vibrating body, such as the diaphragm of a telephone, the wave-form of the motion being obtained by the revolving mirror method.

Messrs. A. Gallenkamp showed some cheap electric furnaces and various laboratory apparatus for heat experiments, including a student's optical bench for radiant heat experiments. They also exhibited a sensitive flame for working at the low pressure of an ordinary gas supply, designed by Prof. S. P. Thompson. The Westminster Engineering Co. exhibited a small useful projection arc lamp for photographic work and optical lanterns. Resistance testing sets were shown by Messrs. Crompton and Co., Evershed and Vignoles, and Nalder Bros., and a large range of switchboard instruments was exhibited by the Weston Co.

RIVERS, GLACIERS, AND THE ICE-AGE.

BRUNO DIETRICH, of Potsdam, has made a geographical study of the Moselle valley ("Morphologie des Moselgebietes zwischen Trier und Alf," *Verhandl. des naturhist. Vereins der preuss. Rheinlande*, 1911, for 1910, p. 83). Basing his description on the geological structure and history of the district, he shows how the valley has been cut in a pre-Miocene surface of denudation. The meanders that arose on this fairly even surface are now traced as winding ravines (p. 120), owing to the elevation of the country and the consequent lowering of the base-level of the Moselle. The tributaries of the left bank, however, are held to have been incapable of forming such large meanders as are now seen in the forms of their ravines. At present they wander somewhat aimlessly in the flat land of their floors, now cutting back one valley-wall, now the other. Their valley-flats (*Talauen*) are attributed to lateral erosion at a time when the land remained stationary for a time (p. 130), and we gather that these flats have become perpetuated during the general lowering of the valley-floors. For those who do not know the details of the ground, the argument seems to require further development, since it may be urged that the large meanders arose when the tributaries received much more water from the drainage of the plateau, while the *Talauen* represent the natural consequence of the diminution in volume of the streams. The "misfit" of a small meandering streamlet in a widely meandering valley reminds us of the conditions of the Altmühl valley, near Eichstätt, which is believed at one time to have held the Danube. An interesting account is given (p. 164) of the changes that have taken place where the Moselle traverses the sunken area of Wittlich. This depression is attributed to Middle Cainozoic earth-movements, and its form has become moulded by the Moselle and its tributaries, which have removed an immense amount of the yielding Permian strata and have left courses illustrating dry loops and river-capture.

E. C. Andrews, in his "Corrasion by Gravity Streams" (Proc. Roy. Soc. N.S. Wales, vol. xliii., p. 204), has urged that running water may work out a hollow in a valley-floor wherever its velocity is increased, as occurs in a constriction of the valley. The greater the velocity, the steeper will be the heads of these hollows, and a series of steps may thus arise in the floor, comparable to those found in valleys that have been filled by ice. Andrews compares the receding heads of the waterfall-regions or torrent-regions with the cirques (p. 282) of glaciated lands; the only cirques considered by him, however, are those that lie at valley-heads. He urges that rivers in flood-time effect so abnormal an amount of denudation that their normal action may be left out of count in considering the formation of their valleys. Similarly, the glacial epoch gave rise to ice-floods, beside which anything that we see now is insignificant (p. 274). Glaciers are considered as a type of "gravity-stream," and the author's studies in Australasia, California, and Scotland, while they do not bring him to any very new conclusions, lead to a pronounced advocacy of the importance of glacial erosion. In vol xliv., p. 262, Andrews illustrates the formation of steps and *roches moutonnées* by plucking action in the Yosemite valley. We do not know why (p. 292) he writes the extraordinary words, "lee seites" and "stoss seites," when he has used the convenient adjectives "downstream" and "upstream" in his previous paper. Here, again, cirques are regarded, not as arising independently on an upland by the corroding action of frost, but merely as the faces of steps formed beneath an ice-flood (p. 305), which have retreated upstream to their present positions on divides. In vol. xlv., p. 116, the author discusses "Erosion and its Significance," and points out that where two peneplane surfaces in association are separated by youthful topography, tectonic movements must have produced the difference of level. The flood-question is again discussed.

P. Morin, of Montluçon, reviews "Le problème de l'érosion glaciaire" in the *Revue générale des Sciences* for 1911, p. 762. He shows how the rock-ridges in the centre of some glaciated valley-floors, which are quoted by Brunhes as evidence of the inefficiency of the ice, may arise from a union of glaciers along arêtes which they have not been able to remove. Others represent the central parts of rock-barriers that lay athwart the ice-flow, the more rapid erosion by frost action and plucking on the margins of the glacier having excavated their ends more rapidly. The paper is agreeably illustrated, and sections are given on a true scale of the floors of glaciers descending from Mt. Blanc.

The late Prof. R. S. Tarr, who made a special province of Alaska, gave a general account of its glacial features in *Science* for February 16, 1912. The burden of sediment in the streams flowing from the glacier-margins led him naturally to ask (p. 250), "Can there be any doubt but that the glacier which protects the rock against the atmospheric agencies must attack it with equal or even greater vigour?" We may, perhaps, refer back to his excellently illustrated paper on "Some Phenomena of the Glacier Margins in the Yakutat Bay Region, Alaska" (*Zeitschrift für Gletscherkunde*, Bd. iii., p. 81), which has enabled many of us to compare outwash-features with those traceable in the British Isles. The results of glacial advance over old deposits are also clearly indicated (p. 102), and a warning is given against interpreting layers of vegetation interbedded with glacial detritus as evidence of an interglacial epoch. "A slight forward motion may well have pushed a broken ice-margin out into the fringing forest," as it did before the author's eyes in the Malaspina region in 1906.

O. D. von Engeln, of Cornell University (*ibid.*, Bd. vi., p. 104), records the results of observations made in Alaska on "Glacier Drainage and Wastage" during two expeditions led by Prof. Tarr. Much interest attaches to the forcing up of marginal streams against the valley-sides (p. 128) when a glacier increases in width; rock-gorges are then cut, parallel to the sides, which may easily again run dry. It is shown (p. 142) how denudation is rapid in an ice-filled valley, even if we neglect the erosive action of the ice, since the removal of the material copiously avalanched from the valley-walls leaves the surfaces continuously open to attack.

G. W. Lamplugh has published in the Proceedings of the Yorkshire Geological Society (Leeds, vol. xvii., p. 216) an important paper on the shelly moraine pushed up by the Sefström Glacier from the sea-floor in Spitsbergen in 1896. The illustrations selected are of exceptional beauty, apart from their geological value as Arctic landscapes.

W. von Lozinski usefully discusses "Die periglaziale Facies der mechanischen Verwitterung" (*Naturwissenschaftliche Wochenschrift*, October 8, 1911). The traces of widespread weathering by frost are destined to disappear as the conditions of the Ice age recede from us. The breaking up of rock-surfaces into block-detritus by frost must have occurred on an enormous scale as glacial conditions spread, and the material thus loosened provided the abundant erratics that were carried by the ice-invasion into the lowlands. Similar block-formations arose as the ice retreated, and also in unglaciated lands subject to its chilling influence; these detrital masses of local origin cumber the surface of large parts of Europe at the present day.

R. A. Daly (*Amer. Journ. Sci.*, vol. xxx., p. 297) publishes a characteristically speculative but suggestive paper on "Pleistocene Glaciation and the Coral-reef Problem," in which he represents the existing reefs as arising on a plateau of marine denudation, which was formed when the sea-level was lowered by the abstraction of its waters to form continental ice.

Those who wish to follow the course or courses of opinion on the origin of Ice ages will find a good review and a new cosmic suggestion in Fr. Nölke's paper, "Die Entstehung der Eiszeiten" (*Deutsche geographische Blätter*, Bd. xxxii., p. 1.). The passage of the sun through a heat-absorbing nebular aggregate is invoked. Ach. Grégoire (*Bull. Soc. Belge de Géologie*, tome xxiii., p. 154) believes that the elevation of a sea-floor to form a continent brings up a mass of cold rock as against one that has long felt the influence of the sun; hence unusual precipitation follows on the new land-surface, and an Ice age sets in. Stanislas Meunier ("Les Théories Glaciaires," *Revue des Idées*, 1910, p. 207) affirms, as usual, that no general and contemporaneous refrigeration has been proved; but he also asserts that the scratches of stones in boulder-clay are produced by the infiltration of rain and consequent settling of the mass. M. Yokoyama ("Climatic Changes in Japan since the Pliocene Epoch," Journ. Coll. Sci., Tokyo, vol. xxxii., 1911, part v.) cannot accept the evolution of carbon dioxide as a cause of warmer climates, since in Japan the output must have been considerable during glacial times. He prefers, from local palæontological evidence, to account for the difficulties by a shifting of the poles. This is, of course, seriously opposed by the evidence of contemporaneous world-wide refrigeration. R. Speight ("The Post-glacial Climate of Canterbury," Trans. New Zealand Inst., vol. xliii., 1911, p. 408) finds no local cause in New Zealand to account for the succession of climates that he records, a moist climate following the glacial, and modified steppe conditions preceding those of the present day. The author points out that the sequence is so similar to that in Europe as to suggest some cause that affected the whole earth, though changes in the grouping of land and water in the southern hemisphere might account for the former conditions in New Zealand.

G. A. J. C.

THE WORK OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT, CHARLOTTENBURG, IN 1911.

THE following notes describe some of the more important researches, &c., undertaken at the above institution during 1911. They are compiled from the annual report of the Reichsanstalt, appearing in *Zeitschrift für Instrumentenkunde*, April, May, and June, 1912.

The comparison of platinum resistance thermometers with various gas thermometers has been completed between 0° and 450° C. It was found that the hydrogen thermometer and the helium thermometer of constant volume with an initial pressure of 620 mm. mercury indicated about 0·1° higher at 450° C. than the nitrogen thermometer under the same conditions. With the accuracy attained, the hydrogen scale may be at once identified with the ideal scale, since, according to Berthelot, these only differ by about 0·01° at 450° C. in the present case. The data for the following fixed points, which were determined afresh, refer to the ideal gas scale:—

Freezing points		Boiling points	
Tin ...	... $231·8_3$°	Naphthalin ...	$217·9$°
Cadmium	... $320·9_2$°	Benzophenon...	$305·8_9$°
Zinc ...	... $419·4_0$°	Sulphur ...	$444·5_1$°

In connection with an investigation of the mean specific heat of gases at high pressures, the specific heat of air between 20° and 100° C. at 1 and 11 atmospheres was measured with a new calorimeter. It was found that when the pressure was increased from 1 to 11 atmospheres the specific heat increased by about 2·1 per cent. This result must not, however, be considered as final at present.

The investigation into the specific heat at constant pressure of air by the Callendar and Barnes continuous-flow method was concluded. The values found for the specific heat at constant pressure of carbonic-acid-free air under atmospheric pressure are given below. The method gives the results direct in electrical measure (watt-seconds); and the values converted into heat units ($Cal._{15}$) are also given.

Temperature °C.	c_p In electrical measure	c_p In calories
+ 20	1·009	$0·240_8$
− 78	1·019	$0·243_2$
− 183	1·058	$0·252_5$

The experiments were extended to carbonic acid gas, oxygen, and nitrogen. For the pure, dry gases, at atmospheric pressure and 20° C., the following results were found in electrical and in heat units respectively:—

Carbonic acid gas c_p = 0·846 and 0·202 respectively.
Oxygen ... ... c_p = 0·917 „ 0·219 „
Nitrogen ... ... c_p = 1·041 „ 0·249 „

For carbonic acid gas at −78° C. and atmospheric pressure the respective results were, $c_p = 0·76_8$ and 0·183. The decrease in specific heat of CO_2 between +20° C. and −78° C. is, when calculated per degree, only slightly less than that between +100° C. and +20° C. determined by Swan.

Specific Heat of Water between 0° and 100° C.—A precise determination of the calorie in electrical units on a trustworthy basis appears very desirable. The bases of the measurement, viz. the unit of resistance, the e.m.f. of the standard cell and the temperature scale, have now been fixed internationally to such a degree of certainty as to appear to render possible a determination of the calorie in international watt-seconds to within 1 part in 10,000. This research was commenced at room temperature, and a description of the various apparatus and of the experimental arrangements is given in the report. No results are, however, recorded.

Weston Normal Cells.—A number of these were constructed, using new mercurous sulphate preparations, with the view of seeing whether all freshly precipitated samples yielded the same e.m.f. as the older preparations, and for the purpose of discovering whether the method of washing the precipitated mercurous sulphate had any influence on the e.m.f. of the cell. The results show that the method of washing has no appreciable influence on the e.m.f. Other extensive investigations were undertaken on Weston cells, and the general results arrived at indicate that both the reproducibility and constancy of the cell can be guaranteed internationally to within a few parts in 100,000.

In connection with some experiments on resistance thermometers, it was found that the differences shown between fused silica platinum resistance thermometers and the ordinary type may be ascribed to a reaction of the quartz glass on the platinum—probably of a chemical nature. Experiments were also made with the view of comparing the behaviour of the quartz glass resistance thermometer at the highest temperatures at which it can be used with the ordinary resistance thermometer. Full details of these experiments are given.

Electrolysis of Glass.—The investigation of the badly conducting layers discovered by Warburg in the electrolysis at 300°–350° C. gave the following result:—

Platinum or graphite anodes are not soluble in glass. On electrolysis, a layer of high resistance occurs at these anodes, sodium migrating from the glass to the kathode and oxygen to the anode. With mercury as anode, quantitative migration takes place. The metals lead, bismuth, antimony, tin, iron, and copper, when oxide-free, appear to migrate quantitatively into the glass. Anodes of lead oxide or copper oxide are insoluble, and exhibit the same phenomena as platinum or graphite anodes.

Among other investigations, either completed or in course of progress, the following may be mentioned:—Anode rays, the Doppler spectrum in canal rays, determination of the constant *c* of the law of black-body radiation, the thermal expansion of metals at high temperatures, electrolytic valvular action, influence of chemical composition and heat treatment on the magnetic and electric properties of iron alloys.

E. S. Hodgson.

AWARD OF BEIT MEMORIAL FELLOWSHIPS.

The trustees of the Beit Memorial Fellowships for medical research have elected the following to fellowships. Each fellowship is of the annual value of 250*l*., payable quarterly in advance. The usual tenure is for three years, but the trustees have power in exceptional cases to grant an extension for one year. The general character of the research which each fellow proposes to follow, and the place of research, are indicated.

Dr. Ida Smedley, the processes involved in the formation of fat in the organism (the Lister Institute of Preventive Medicine). Dr. R. A. Chisolm: An investigation into the production of experimental nephritis by various methods, and the problems arising therefrom (the Pathological Department, Guy's Hospital). Dr. D. V. Cow: (1) Investigation of the diuretic action of certain tissue extracts, especially of an extract obtained from the intestinal mucous membrane; (2) investigations of certain bacterial diseases with the object of ascertaining any possible beneficent action thereon of organic compounds of a non-toxic nature (the Pharmacological Laboratory, Cambridge). Miss Elsie J. Dalyell: Investigation of gastro-enteric diseases in infants, with reference to etiology (bacteriological research), influence of diet (chemical and bacteriological research), vaccine therapy as a protective and curative measure (Lister Institute of Preventive Medicine). Dr. C. Funk: An investigation into the nature of the so-called deficiency diseases (beri-beri, scurvy, &c.), with special reference to the chemical nature and physiological properties of the substances concerned in their etiology and prevention (the Lister Institute of Preventive Medicine).

Prof. A. B. Macallum: Problems in metabolism in disease, especially those concerned with the formation of urea, ammonia compounds, and uric acid and their excretion (Prof. Fredrik von Müller's Laboratory, Munich). Dr. J. McIntosh: Certain problems concerning the immunity of syphilis (Bacteriological Laboratory, London Hospital Medical College). Dr. S. W. Patterson: (1) Questions concerned with diabetes, especially the fate of lævulose in the normal and diabetic organism; (2) later, to investigate the toxæmias of intestinal origin, especially the influence of different forms of diet on the production of poisonous products, amine derivatives of amino-acids, &c. (Institute of Physiology, University College, London). Miss Helen L. M. Pixell: The life-histories of parasitic protozoa (the Protozoology Laboratory, Bedford College, and the Lister Institute of Preventive Medicine). Dr. H. L. H. Schütze: Studies concerned with the modern absorption theory of the union between bacillary antigen and the antibodies of the blood serum (the Lister Institute of Preventive Medicine).

All correspondence relating to the fellowships should be addressed to the honorary secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, Piccadilly, W.

ZOOLOGY AT THE BRITISH ASSOCIATION.

Section D, which was largely attended, presented a very full and varied programme, and the interest in the meetings of the section was well sustained throughout.

A lantern lecture, of a semi-popular nature, was given by Mr. F. Balfour Browne, on the life-history of a water-beetle. After describing his methods of keeping and rearing water-beetles, he proceeded to detail the life-history of a type of each of the two groups of water-beetles, taking *Dytiscus lapponicus* as a type of the group Hydradophaga, and *Hydrocharis caraboides* as a type of the group Palpicornia. The former, which has a very restricted distribution in the British Islands (N.W. Ireland and W. Scotland), being apparently a remnant of the fauna which in earlier and colder times occupied this area, seems to be the first species of the genus the life-history of which has been followed in detail. Mr. Balfour Browne gave an account of the egg-laying habits, the development of the larva and its escape from the egg by means of a pair of small spines on the head, the scraping of which against the shell ultimately ruptures it, and allows the larva to wriggle out. He stated that the larva, in addition to sucking the juices of its prey, from time to time reverses the action of its pharyngeal pump, so as to pour digestive juice into the prey (*e.g.* an insect larva), so that all the soft parts are dissolved and a thin pellicle of chitin only remains. He showed how the larva, after it is full grown and leaves the water, builds the pupal cell, and he referred to the winter habits of the perfect insect. He then compared the life-histories of Hydrocharis and Dytiscus, and pointed out how each type has adopted different means to attain the same end, and that it was just such differences which enabled each species to hold its own in its particular community in the great struggle for existence.

Foraminifera.

Messrs. Heron-Allen and Earland maintained that the life-history of Saccammina, as described by Rhumbler, was a composite sketch, and involved three separate organisms: (1) the early phases were stages of *Crithionina mamilla*, a sessile rhizopod, which, although often associated with *S. sphaerica*, has a wide distribution apart from that species; (2) the next phase was really *Psammosphaera fusca*, an extremely variable species, occurring both free and sessile, always without a general aperture, and found under conditions of depth, &c., in which Saccammina never exists; (3) the "Saccammina" stages, described by Rhumbler, which represent the complete life-cycle of *S. sphaerica*. Early shell-bearing stages of this species differ from the adult only in their smaller size, somewhat less finished exterior, and in the form of the general aperture, which is at first a mere fissure. The nipple-like protuberance, on which the aperture of the adult is placed, gradually develops later.

The Isle of Wight Disease of Bees.

Dr. H. B. Fantham gave an account of the causal organism of this disease—a minute microsporidian parasite, *Nosema apis*—which was discovered by Dr. Annie Porter and himself. The organism is, in the main, a parasite of the alimentary tract of the bee. Spores of the parasite, swallowed by the bee, give rise each to an amœbula, which enters an epithelial cell of the gut, becomes rounded, grows and feeds for a time, and then begins to multiply by various types of binary fission, producing clusters or chains, each individual of which is ultimately uninucleate. The presence of these parasites causes derangement of the bee's digestive processes, and may be fatal.

The second phase of the life-cycle (sporogony) leads to the formation of pansporoblasts, each of which becomes converted into a spore, which serves for the transference of the parasite to a new host. The symptoms of this disease, which has been termed microsporidiosis, vary; inability to fly, crawling, dislocation of the wings, abdominal distension, and "dry dysentery," followed by early death, may be noted. Warm weather favours the bee, damp aids the parasite. The method of infection is contaminative. Hives, comb, honey, and pollen from comb, bees' drinking places, flowers, water from foliage, and dew near infected hives have been observed to contain spores. Some bees can adapt themselves somewhat to the parasite, which forms crops of spores within them, and these bees act as reservoirs of the disease.

Preventive measures seem to be of most value in treating this disease. The only certain destructive agent for Nosema spores is fire. All dead bees should be burned, old combs and hives untreated by a painter's lamp are to be avoided, and it should be remembered that old wax is not sterilised by being merely melted. Weak stocks of bees should not be united, and great care should be exercised in importing bees from other places in the British Isles or from abroad. Provision of abundant honey and pure water supply, together with scrupulous clealiness of the hive and its surroundings, are great aids in the prevention of microsporidiosis.

Prof. Minchin directed attention to the fact that hereditary infection of bees by *N. apis* had not been found to take place, whereas the allied parasite (*N. bombycis*) of silkworms penetrated the ovary, and entered the eggs, so that the next generation was born infected. The latter parasite was able thus to tide over the winter. Hereditary infection of bees with *N. apis* was not necessary to enable the parasite to tide over the winter, for it can pass the winter in hibernating adult bees.

A Sessile Ctenophore.

Dr. Th. Mortensen gave an account of a sessile Ctenophore—*Tjalfiella tristoma*—found attached to the stems of Umbellula taken off west Greenland. This Ctenophore is compressed, elongated in the transverse plane, and has lost its costæ. The apical organ is rudimentary, being—as a static organ—of no use in a sessile organism. The tentacles are simple, and there is a branching canal system, as in Cœloplana and Ctenoplana. The animal is viviparous; its eggs develop in brood-chambers on the sides of the body, giving rise to cydippiform young, which swim, for a short time, by means of their well-developed costæ, then become attached by the mouth and at once begin to assume the adult form. Tjalfiella is closely related to Cœloplana, and especially to Ctenoplana, and Dr. Mortensen held that its anatomy and development support the Selenka-Lang theory of the origin of Polyclad Turbellaria from Ctenophores.

Mr. E. S. Goodrich expressed himself as unwilling to accept the view that Polyclads were derived from Ctenophores. But even if these two groups were related, they must have diverged in remote time, and it seemed to him inconceivable that their common ancestor should be still extant. Prof. Dendy did not share this view.

Papers on Helminthology.

Dr. W. Nicoll gave a *résumé* of recent progress in helminthology. He directed attention to the use of internal instead of external features as the basis of specific diagnosis, and to the correlation between habit and systematic position, which is clearly brought out by the new method of classification. He noted the great importance of the discovery that infection by Ankylostoma and Schistosomum takes place through the unbroken skin. Turning to morphological questions, he directed attention to the so-called "shell-gland" of Trematodes, pointing out that recent researches have shown that the shell-substance is secreted by the "yolk-glands," and that the function of the "shell-gland" remains unknown. Of interest also is the discovery of the existence of a communication between the intestine and the excretory vesicle in certain digenetic Trematodes.

Mr. J. W. Chaloner has investigated a disease of trout in Loch Morar, due to a larval Bothriocephalid (plerocercoid larva), found encysted in the wall of the intestine and adjacent organs, the cyst-wall being formed by the tissues of the trout. The larvæ varied in length from ¼ to 8 in. The birds of the loch were examined, and, in an adult merganser, a Diphyllobothrium—possibly the adult of the larva described—was found. All the merganser were found to be infected with the larval and adult sexual form of *Schistocephalus gasterostei*, obtained from the sticklebacks, which form a large part of the food of these birds.

Papers on Polychaeta.

Prof. W. C. M'Intosh directed attention to the close structural resemblances between the genus Filograna, which has an operculum for closing the tube, and Salmacina, which has no operculum. It was shown that the presence or absence of an operculum was not a point on which great dependence could be placed, since in the north—Shetland, Moray Firth, St. Andrews—amidst vast swarms of those devoid of opercula, a few occurred with them. Further, it was shown that the opercula are exceedingly variable in development, and that when they are absent the tips of the branchial filaments show great susceptibility to growths of a more or less conspicuous character; especially is this the case in Neapolitan specimens. The branchial pinnæ are variable in length according to the age or surroundings of the specimen, and the bristle-tufts of the anterior region likewise vary from five to ten pairs; yet, throughout the whole series of those with or without opercula, the structure of the bristles is precisely the same. Both forms are gemmiparous. After examining numerous examples and noting the plasticity of the organs, Prof. M'Intosh said he would prefer to refer all the forms to one species of the genus Filograna.

Mr. F. A. Potts gave an account of the habits of a new species of Phyllochætopterus, found living in shallow water off Vancouver Island. It lives in creeping tubes of translucent material, which generally possess several openings, each situated at the end of a branch of the main tube. In nearly all tubes more than one individual is present, sometimes as many as six. The tube is constructed, in the first place, by a single individual, which is formed from a fertilised egg; this worm propagates itself by autotomy, the posterior part becoming detached and regenerating an anterior region. Modification and branching of the tube occur to suit the increasing population. Circulation of water in the tube is maintained by the movement of cilia on the median segments and by undulatory movements of the abdomen.

Mr. Potts also described the formation, in Trypanosyllis sp., of reproductive buds, to the number of one to two hundred, from a patch of tissue extending over the ventral surface of the last one or two segments. Ectoderm and mesoderm alone take part in the formation of these buds: there is an entire absence of alimentary canal. In *T. gemmipara*, from the N.W. Pacific, bud-formation is accompanied by the rapid addition to the stock of a tail of forty to fifty segments, which, unlike the buds, contains a prolongation of the alimentary canal of the stock, and, like the buds, develops generative products. In the earliest stage of proliferation observed, the body-cavity near the region of proliferation was filled with leucocytes, which also migrated into the cushion of mesoblast present immediately within the thickened ectoderm. Mr. Potts suggested that these leucocytes served a nutritive function, and also that they gave rise to the greater number of the mesoblast cells, from which are formed the gonads, cœlomic epithelium, and connective-tissue. The muscular and nervous systems of the bud grow out from those of the stock.

Dr. Cresswell Shearer traced the development of the mesoderm and the head kidneys of Pomatoceros, which he found to follow the same course as in Eupomatus (see Q.J.M.S., vol. lvi., 1911, pp. 568–585).

Papers on Echinoderms.

Dr. J. F. Gemmill described the development of the starfish *Asterias rubens.* The eggs were artificially fertilised in April at the Millport Marine Biological Station, and, at an early stage of segmentation, were taken to the University of Glasgow, and kept there in small aquaria provided with a simple "convection current" system of internal circulation. Metamorphosis took place in seven or eight weeks. The chief features of the bipinnaria and brachiolaria larvæ were described, as were also several interesting cases of double hydrocœl. Dr. Gemmill concluded that the epigastric and hypogastric cœloms correspond on the whole with one another and with the right and left body-cœloms of Balanoglossus, while the dorsal sac, which pulsates subrhythmically, is the homologue of the "pericardial vesicle."

Prof. E. W. MacBride gave an account of his studies, made at Millport, on the development of *Echinocardium cordatum,* the larvæ of which he was able, by feeding on the diatom Nitschia, to rear until they metamorphosed into young heart-urchins, which took place about eighteen to twenty-three days after fertilisation. The egg segments rapidly and forms an ellipsoidal blastula, which escapes from the egg-membrane. This becomes converted into a gastrula, which bears anteriorly a tuft of specially long cilia. Soon the formation of the skeleton and the arms of the larva is initiated. The cœlom arises as an unpaired vesicle nipped off from the apex of the archenteron, and becomes divided into right and left halves. Both right and left cœlomic vesicles send out prolongations which become pore-canals, and open to the exterior, but subsequently the two pores merge in a single median pore from which right and left pore-canals diverge. Prof. MacBride traced the metamorphosis of the larva, and pointed out that the mouth of the young Spatangoid is surrounded by five plates, from each of which springs an inwardly directed spine, the rhythmical movements of which suggest that they represent the teeth of the regular Echinoids.

Mr. H. M. Fuchs described work done at Plymouth on the hybridisation of species of Echinus. Three species—*E. acutus, esculentus,* and *miliaris*—were used in the experiments, and the early and variable larval characters were discarded in favour of more definite features developed by the later plutei. The late plutus of *E. miliaris* has no posterior epaulettes, but has a pair of green pigment masses on the anterior epaulettes; the late plutei of *E. acutus* and *E. esculentus* possess a pair of posterior epaulettes, but lack the green pigment. In 1909, 1910, and 1911 it was found that the inheritance of these characters in reciprocal hybrids between *E. miliaris* and *E. esculentus* or *E. acutus* was invariably maternal. During the spring and summer of this year the experiments have been repeated, and it has been found that the inheritance is different from that of previous years. All cultures of the crosses *E. esculentus* ♀ × *E. miliaris* ♂ and *E. acutus* ♀ × *E. miliaris* ♂ have been maternal, as previously, with one exception. In that case some of the larvæ possessed posterior epaulettes, some lacked them, and some had an epaulette on one side only. The crosses in which *E. miliaris* was the female parent were this year obtained only with difficulty, and, with one exception, they showed a purely paternal inheritance, *i.e.* an exact reversal from the condition of former years. The exception mentioned was the only case in which a large percentage of the eggs developed; the resulting larvæ were some of the paternal and others of the maternal type. No parallel seems to be known for this reversal of inheritance, the cause of which is unknown, but Mr. Fuchs suggested that it was due to a condition of the parents and not to the environment of the larvæ.

Miss Jordan Lloyd described methods of raising parthenogenetic larvæ of *Echinus esculentus.* The method found most successful consisted in treating the unfertilised eggs first with butyric acid to cause membrane-formation (Loeb's method), and then with tannic acid and ammonia in a mixture of sea water and cane sugar (Delage's method). In this way as many as 90 per cent. of the eggs have produced blastulæ, and the larvæ were vigorous and grew for the first three weeks as rapidly as larvæ from fertilised eggs. A few of the larvæ completed their metamorphosis, but the young urchins have not been kept alive more than a few days.

A New Parasitic Copepod.

Prof. H. F. E. Jungersen described *Chordeuma obesum,* a new parasite copepod found enclosed in a membranous capsule formed by the host—*Astronyx loveni.* Sometimes these cysts are extremely numerous, and in these cases the gonads of the host seem not to develop. A cyst which encloses a ripe female contains also its eggs and brood, and usually also a male and empty spermatophores. Embryonic development and most of the post-embryonic metamorphoses occur inside the cyst. Cyclopiform larvæ are liberated from the cyst, and either settle in the same host, thus augmenting the stock of parasites, or leave by way of the bursal apertures to infect other Astronyx, which they enter through the corresponding openings. In both cases the larva fixes itself by its hooked maxillæ, and causes the production of a cyst. The larval cuticle is cast off and the adult form assumed. The adult female is about 5 mm. long and sausage-shaped. Eyes, mandibles, and maxillulæ are wanting. The mouth leads through the pharynx and narrow œsophagus into a capacious stomach, but there is no intestine and no anus. The adult male is not more than 2 mm. long, subcylindrical in form, and has fundamentally the same structure as the female. The nauplius larva has the typical three pairs of appendages, but eyes are wanting, as in all later stages. There are three metanauplius phases followed by the cyclops stage, which is liberated from the maternal cyst. Prof. Jungersen stated that he could not at present indicate the systematic position of this new parasite.

The Luminous Cells of Pyrosoma and Cyclosalpa.

Prof. Ch. Julin detailed the histological characters of the luminous cells of *Pyrosoma giganteum.* Each of these cells contains a closely convoluted tube, the wall of which is achromophile and is traversed by an achromophile reticulum, on the knots of which are numerous granules of nuclein, an albuminous substance rich in phosphorus. The tube is entirely immersed in a small amount of liquid, which fills the remainder of the cell. Prof. Julin then passed to consider the lateral luminous organs of *Cyclosalpa pinnata,* in which the cells are smaller than in Pyrosoma. In the substance of the cell lies a convoluted tube, frequently found to be broken up into vesicles. The tube is traversed by a reticulum bearing many nuclein granules.

Prof. Minchin suggested that the luminous particles, being formed in cytoplasm, might be volutin and not chromatin, and that the tube in the cell might be a schizomycete commensal or parasite.

An Hermaphrodite Amphioxus.

Mr. Goodrich described, and exhibited sections of, an hermaphrodite specimen of Amphioxus, found at Naples in the summer of 1911. It is an adult ripe male with twenty-five gonads on each side. All these are typical testes containing spermatozoa only, with the exception of the ninth gonad on the left side, which contains ova only, and is a typical ovary. This appears to be the first instance of hermaphroditism described in the Cephalochordata.

Scottish Sea Fisheries, 1898–1912.

Prof. W. C. M'Intosh held that a careful perusal of various statistical returns does not lead to pessimistic views of our fisheries, but rather bears out his views as to the safety of the supply of food-fishes. The herring, cod, haddock, plaice, lemon dab, sole, and turbot have been in turn the subject of gloomy forebodings, but the speaker maintained that not one of these was on the road to extinction or even to serious diminution.

Prof. Ewart pointed out that the appliances now used in fishing were more efficient than those in use fifteen years ago, but, as the take of fish had not increased in proportion, it seemed as if fish were less abundant than formerly.

Dr. Petersen remarked that, until statistics were available for the whole of the North Sea, the problem could not be fully discussed.

Reissner's Fibre and the Subcommissural Organ in the Vertebrate Brain.

Prof. Dendy described the subcommissural organ as a groove, or pair of grooves, lined by elongated, ciliated, epithelial cells, and situated beneath the posterior commissure. From these cells originate a large number of slender fibrils—probably elongated cilia—united together to form Reissner's fibre, which extends, as a highly elastic, tightly stretched thread, backwards through the brain-cavities and central canal of the spinal cord to the extreme end of the latter, where it is attached to a plug of connective-tissue lying in the *sinus terminalis.* Reissner's fibre and the subcommissural organ are well developed in all the great vertebrate groups from cyclostomes to primates. Prof. Nicholls's recent researches have shown that Reissner's fibre is not nervous (as it was believed to be by Sargent). Prof. Dendy has suggested that the subcommissural organ might be a kind of intra-cerebral sense-organ, concerned, with Reissner's fibre, in automatically regulating the flexure of the long axis of the body. Prof. Nicholls's recent experiments on fishes support this view, and further support is derived from the fact that in man, with his erect posture and but slightly flexible vertebral column, the subcommissural organ is reduced to a mere vestige—the mesocœlic recess—and Reissner's fibre is probably absent.

Papers on Birds.

Miss Laura Florence, who has examined the crops of about 1800 birds, belonging to ninety-five species, chiefly from agricultural land in the north-east of Scotland, with the view of finding which were injurious and which beneficial, gave a summary of her results. She emphasised the need for examining large numbers from different areas, and throughout the year, if trustworthy information is to be forthcoming. In some cases the verdict given by previous investigators has been confirmed, *e.g.* as to the injuriousness of the house sparrow, wood pigeon, and carrion crow, and as to the beneficial activity of the hedge sparrow, fieldfare, lapwing, and plovers. On the other hand, there are several cases in which the results up to the present do not confirm previous opinions, *e.g.* the diet of the black-headed gull and the common gull shows a striking resemblance to that of the useful lapwing.

Mr. A. Landsborough Thomson contributed a note on the method of bird-marking—by a light metal foot ring with inscription—applied by the Aberdeen University inquiry, which has already yielded interesting facts, *e.g.* records of an English-bred swallow returning to the breeding place the following summer, a Scottish-bred swallow returning to its birthplace the following summer, a Scottish-bred song-thrush migrating to Portugal in its first autumn, &c.

The Development of the Thymus.

Prof. J. P. Hill communicated a *résumé* of observations by Miss E. A. Fraser and himself on the development of the thymus, thyroid, and epithelial bodies in the marsupial *Trichosurus vulpecula,* and emphasised the following points—(1) the origin of the superficial cervical thymus, in major part at least, from the ectoderm of the cervical sinus; (2) the derivation of thymus iii. from the ventral as well as the entire caudal wall of cleft iii., thus affording a transition, as regards mode of origin, between thymus iii. of the lizard and that of Eutheria; (3) the presence of a well-developed thymus iv., a feature characteristic (so far as is known) of marsupials alone amongst the mammals; and (4) the lack of any topographical relationship of the epithelial bodies to the thyroid.

Fat-tailed Sheep.

Prof. J. C. Ewart discussed the origin of fat-tailed sheep. He considered it probable that, as the large inland seas common in Central Asia in prehistoric times dried up, domesticated sheep, to have a chance of surviving, found it necessary to store up fat as a means of providing nourishment during the long, dry season. In some cases fat was deposited to form fat-rumped races, in others to form fat-tailed races. Those individuals which, by increasing the number and length of the tail vertebræ, provided most accommodation for fat would, in the struggle for existence, have the best chance of surviving, as the aridity in Central Asia increased. Prof. Ewart considered it extremely probable that the long-tailed European breeds, instead of inheriting their long tails from an extinct long-tailed wild ancestor, as used to be assumed, are indebted for their long and apparently useless caudal appendages to fat-tailed ancestors. Evidence in support of this view is afforded by the fact that the fat in the tail gradually disappears when a sheep of the Afghan type is removed from the arid deserts of Central Asia to Western Europe, where green food is available throughout the year.

Survey of the Fresh-water Fauna of India.

In his account of the survey of the fresh-water fauna of India, which is now being carried out by the Indian Museum, Dr. N. Annandale laid great stress on the importance of the fauna of any country being worked out in that country, and on the association of a study of the biology of a group with taxonomic research on that group. The recent liberal policy of the trustees of the museum, and the generosity of the Indian Government, had resulted in the acquisition of first-class zoological laboratories, and an excellent collection of zoological literature. He directed attention to the considerable number of zoologists now working in India, and to the zealous cooperation of numerous correspondents and collectors in different parts of the country. His paper was illustrated by photographs of the Indian Museum and its laboratories, and of species in the fresh-water fauna of special interest from a biological or taxonomic point of view, *e.g. Trygon fluviatilis*; Hislopia, *Pectinatella burmanica*, and other Polyzoa; fresh-water sponges and their gemmules; and a new Temnocephalid.

Zoological Results of the Scottish National Antarctic Expedition.

Dr. W. S. Bruce pointed out that the *Scotia* was fitted out especially for deep-sea work in high southern latitudes within the limits of pack ice. The result was a large collection of animals in the region of the Weddell Sea, from the surface down to a depth of 2000 fathoms. Altogether eighteen new genera and 263 new species have been found in the collections up to the present, particularly striking being the large percentage of new species from great depths, *e.g.* of sixty species of Echinoderms forty-four are new. The collections do not lend any support to the bipolarity theory.

Plankton of Lough Neagh.

Dr. W. J. Dakin and Miss M. Latarche presented a summary of their work on the plankton of Lough Neagh. Both the phyto- and zoo-plankton are made up of Arctic and central European species existing side by side. The authors do not accept the Wesenberg Lund-Ostwald theory—that seasonal variations in planktonic organisms are due wholly to changes in the viscosity of the water; such changes appear to be due chiefly to direct action of the temperature and the food supply. *Mysis relicta* was found in great abundance at the surface of the lough at midnight, whereas in daylight it was absent or rare.

Biological Science and the Pearling Industry.

Dr. H. Lyster Jameson reviewed the scientific work which has been done up to the present with the view of rendering the pearl and mother-of-pearl producing industries more profitable, and stated that, so far as he knew, the Japanese "culture-pearl" enterprise was the only instance of the application of biological knowledge to the improvement of this industry which had proved an unqualified business success. He suggested that there should be some organising machinery which would bring to bear on this and similar problems all available specialist opinion.

Prof. L. Rhumbler discussed the relation of the mechanics of the cell to the mechanics of development, and showed, by some examples, how the study of the dynamic properties of cells, already established by the study of cell-mechanics, is able to elucidate physically, in a simple manner, whole series of phenomena exhibited by the behaviour of embryonic cell-complexes. Dr. C. J. Bond discussed the method by which the individual organism becomes adapted to new environmental stimuli by use-acquirement, and the dependence of use-acquirements on variation and selection of intracellular units. Dr. J. Wilson held that the "presence-and-absence theory" of inheritance was unsound. Prof. R. J. Anderson gave a paper on "speech" in animals, and notes on the skull of a grampus. These last five papers do not lend themselves to the purposes of a summary.

In the laboratories adjacent to the meeting-room there was an exhibition of interesting specimens:—Antarctic fauna (Dr. W. S. Bruce); Leduc's osmotic growths (Mr. Deane Butcher); molluscan histology and development of cartilage in young plaice (Dr. Dakin); sexual dimorphism in butterflies (Dr. F. A. Dixey), Foraminifera (Messrs. Earland and Heron-Allen); aërating and larva-hatching apparatus, and records showing the use of Aristotle's lantern in the locomotion of Echinus (Dr. Gemmill and Mr. Elmhirst); preserved specimens of Crustacea, &c., in which the articulations were flexible (Dr. Loir); apparatus for the "valuation" of the sea (Dr. C. G. J. Petersen); invertebrates from the Pacific coast of North America (Miss Pixell); Rotifera (Mr. C. F. Rousselet); specimens and drawings illustrating the diversity of size, form, and colour in Alcyonaria (Prof. J. A. Thomson), and nesting-boxes (Mr. W. M. Webb).

J. H. ASHWORTH.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The vacancy in the Waynflete professorship of chemistry has been filled by the appointment of Dr. W. H. Perkin, F.R.S., professor of organic chemistry in the University of Manchester. Dr. Perkin has been admitted as a Fellow of Magdalen College.

Sir William Schlich, F.R.S., has offered to make over to the University a sum of 690*l*. 18*s*. 8*d*. as a contribution towards a fund for the permanent endowment of the professorship of forestry. On December 14 the offer was gratefully accepted by Convocation. Attention may be directed to the fact that the delegates for forestry propose to appoint a research officer to investigate diseases of trees, for a term of two years, at a salary of 400*l*. a year, besides travelling expenses. The research officer will begin work on February 1, 1913, or as soon after that date as may be possible. He will work in connection with the Oxford School of Forestry.

DR. T. MARTIN LOWRY has been appointed lecturer on chemistry at Guy's Hospital Medical School.

BY the will of Mr. R. J. Montgomery the sum of 5000*l*. is left to the Board of Dublin University and the Royal College of Surgeons, Ireland, for a "Mary Louisa Montgomery Lectureship" in ophthalmology, to be held alternately by the said boards for a period of five years, the lectureship for the first five years after his death being held by Dublin University.

MR. EDWIN TATE, J.P., has given to the Battersea Polytechnic the sum of 7000*l*., the interest upon 5000*l*. of this sum to be utilised for scholarships, and the interest upon the remaining 2000*l*. to be devoted to the purchase of books for the Tate Library, which was also generously given by the same donor. The gift is another instance of the interest which the Tate family has always shown to the Battersea Polytechnic.

THE Royal Commissioners of the 1851 Exhibition acting on the recommendation of the Council of the Institution of Naval Architects, have appointed Mr. P. Y. Brimblecombe, late of Armstrong College, Newcastle-on-Tyne, to the post-graduate scholarship in naval architecture, 1913 (of the value of 200*l*. per annum, and tenable for two years), for the purpose of carrying out a course of research work in naval architecture at the Armstrong College.

It is understood by *The Times* that the Royal Naval College, Osborne, is to be rebuilt permanently on the present site at a cost of 200,000*l.*, and that the work will be begun almost immediately. A little time ago a committee of Admiralty officials, including the Director of Works, visited Christ's Hospital for the purpose of inspecting the new buildings there, and it was then stated to be likely that somewhat similar building plans were in preparation for a new college at Osborne.

A CONFERENCE week of educational associations will be held in the University of London, South Kensington, London, S.W., from January 6 to 11. Sir Henry Miers, F.R.S., Principal of the University, and Dr. M. E. Sadler, Vice-Chancellor of the University of Leeds, will speak at the opening meeting, to which members of all the associations are invited. Thirteen educational associations, including the Geographical Association and the Association of Teachers of Domestic Subjects, are taking part. We notice that the presidential address to the Geographical Association will be delivered on January 9 by Prof. E. J. Garwood, who will speak on Arctic glaciers and glaciated features of Britain.

THE annual meeting of the Mathematical Association will be held on Wednesday, January 8, 1913, at the London Day Training College, Southampton Row, London, W.C. At the morning meeting an address will be delivered by the president, Prof. E. W. Hobson, F.R.S., and there will be papers on map projections, by Mr. E. M. Langley, and the income and prospects of the mathematical specialist, by Prof. G. H. Bryan, F.R.S. After the election of president and other officers of the council, in the afternoon, the papers will be "Intuition," by Mr. G. St. L. Carson; "The Advisability of Including some Instruction on the History of Mathematics in the School Course," by Miss M. E. Barwell; and "The Teaching of the Scholarship Candidate in Secondary Schools," by Dr. W. P. Milne. There will also be an exhibition of scientific apparatus and books. Mr. E. M. Langley will exhibit the set of mathematical plastographs (designed and drawn by Mr. F. G. Smith) which were shown by him at the International Congress, and also some folding-paper and other models connected with the study of solid geometry.

THE London County Council has arranged to hold its annual conference of teachers on three days, January 2–4 next, at Birkbeck College, Bream's Buildings, Chancery Lane, London, E.C. The morning meetings will commence at 11 a.m., and those in the afternoon at 2 p.m. Addresses will be delivered at the first meeting on the Montessori method of education, at the second on reading and writing, at the third on "attention," and at the fourth on school hygiene, when Prof. Leonard E. Hill, F.R.S., will speak on open air and exercise. The last two meetings will be devoted to descriptions of educational experiments in schools. Application for tickets of admission, for which no charge is made, should be sent to the Chief Inspector, London County Council Education Offices, Victoria Embankment, London, W.C. The North of England Conference will meet on January 2–4 in Nottingham, at the University College. During the conference two united sessions will be held; the first, on January 3, will hear papers read by the Bishop of Lincoln, on the function of university education in civic life, and by Mr. P. E. Matheson on the educational outlook. At the second united session Sir William Mather will speak on the co-operation of employers and education authorities, and Mr. George Cadbury on the educational responsibilities of the employer. Other subjects of educational interest will be dealt with in sectional meetings, for which a very varied programme has been provided.

A MEETING of the Junior Institution of Engineers was held on December 11, when the president, Sir A. Trevor Dawson, gave an address, taking for his subject, "Staff Officers in Industrial Works: their Scientific and Practical Training and Duties." The demand now, he said, is for well-trained youths having experience of materials, mechanical methods, and men. There is a national need for more highly trained engineers—men combining scientific and practical knowledge, and having experience of materials, methods, and men, to serve on the staff of works. Engineering is a profession which constantly extends its boundaries. It is recognised, for instance, that the advent of an oil turbine—the most desired of all prime movers—was delayed largely by the absence of a metal for the blades which would stand the temperature of the gas impinging on them. This and other examples prove the need for wider technical training and sympathies. In all departments of applied mechanics there is need, too, for the creative mind, for inventive and adaptive genius. Is it not obvious, he said later, that if we are to maintain our position as a great industrial nation there must be advance in the science and practice of engineering? Other States adopt methods for assisting industry by helping to train men capable to take staff appointments in industrial factories. It is true that our great technical institutions are not excelled in any country in the world, and it is creditable also that our great City companies and many private endowments have assisted many men to prosecute their engineering studies at such institutions. Yet the results have proved unsatisfactory, alike from the point of view of the student and the nation. The absence of practical training, of early contact with the workshop, deprives those students in most cases of an indispensable part of their preparation for future industrial work, and interferes with their finding a suitable vocation after their college course has been completed.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, November 21.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Dr. A. B. **Rendle**: Mr. P. A. Talbot's collection of plants from Southern Nigeria.—Rev. George **Henslow**: Vegetable mechanics. The object of this paper is to show that plants respond to gravity, strains, and stresses, in order to resist them and so secure stability.—Miss Nellie **Bancroft**: Some Indian Jurassic Gymnosperms. The fossil plants under consideration are of Liassic age, and come from Amrapara in the Rajmahal Hills in Bengal. The types represented are Gymnospermous, and include examples of *Brachyphyllum mamillare, Benstedtia,* coniferous wood, small bilateral seeds, and Cycadean stems, leaves, and fructifications. The structural evidence obtained, in conjunction with the external morphology of the specimens, supports the already accepted idea of a uniform Mesozoic flora.

December 5. Prof. E. B. Poulton, F.R.S., president, in the chair. E. J. **Bedford**: Notes on two orchids new to east Sussex. Further notes on several rarer species of the Orchidaceæ. The author is engaged in obtaining a series of photographs of the British wild orchids, his intention being to secure photographs of every possible species *in situ*, as well as at closer quarters at home, when arranged against a plain background. During the season of 1911 he was fortunate enough to obtain two species not hitherto recorded for east

Sussex. The first of these was the brown-veined orchid, *Orchis purpurea*, found in the Ouse district, near Lewes, in the month of May, by Mr. Herbert Jenner, of Lewes. This interesting find was the prelude of another of perhaps even greater interest, for in the month of June the author found a specimen of the rare lizard orchid, *Orchis hircina*, in the Cuckmere district near Eastbourne. The author's collection of photographs at present consists of thirty-three species and varieties out of a possible forty-four.—Prof. W. A. **Herdman**: Spolia Runiana, I., the Hebridean Diazona described as "Syntethys," and other rare or interesting animals obtained on the cruise of the S.Y. *Runa* in 1912. The chief forms discussed were:—(1) The giant sea-pen, *Funiculina quadrangularis*; (2) the pelagic Tunicate, *Doliolum tritonis*; and (3) the large green compound ascidian, described by Forbes and Goodsir in 1851 as *Syntethys hebridicus*, but now shown to be the same as *Diazona violacea*, Savigny, from the Mediterranean.

Physical Society, November 22.—Prof. C. H. Lees, F.R.S., vice-president, in the chair.—Prof. E. G. **Coker**: a column-testing machine. The conditions of fixture of the ends of columns, and the large influence this has upon their strength, generally make it necessary to use special testing machines for these members, in which the end plates applying the load are accurately parallel, and remain so during a test. If only rough measurements of the load are required this offers no serious difficulty, but accurate measurement involves elaborate mechanical devices, some of which are briefly referred to in the paper. This difficulty is overcome in a simple manner by supporting one pressure plate by two or more annular diaphragms spaced at considerable intervals, and clamped at their outer edges to a fixed casing in such a manner that only one degree of freedom is possible. This construction is carried out in the machine described in the paper.—C. E. **Larard**: The law of plastic flow of a ductile material and the phenomena of elastic and plastic strains. The author gave an account of the twisting to destruction at a uniform angular velocity of a cylindrical steel specimen 3 in. diameter, and of his deductions from the experimental data. The following deductions were made:—(1) The rate of increase of the torque with the time varies inversely as the time. (2) The acceleration of the torque velocity which is negative or, as it may be called, the deceleration, varies therefore inversely as the square of the time. (3) The variables, time t, and torque T, are connected by the compound interest law. More exactly $t+t_0=a\epsilon^{b\mathrm{T}}$, where t_0 is a time constant. Corresponding results in terms of the angle of torsion θ and T obviously followed, since $\theta=\omega t$, where ω is the angular rate of straining. The author next proceeded to summarise certain other conclusions he has formed as a result of many experiments extending over five years, illustrating his arguments by means of original diagrams, but reserving the full account for later publication.—C. E. **Larard**: Kinematograph illustrations of the twisting and breaking of large wrought-iron and steel specimens. The tests illustrated the Northampton Institute testing machine in operation, showing torsion tests on the following:—(1) A piece of mild steel, $2\frac{1}{2}$ in. diameter. (2) A piece of wrought-iron of the same dimensions. (3) A wrought-iron shaft, $2\frac{1}{2}$ in. square. (4) A rectangular bar of steel, $3\frac{1}{2}$ in. by $1\frac{1}{2}$ in. (5) A steel tube, $3\frac{1}{2}$ in. diameter, with the wall $\frac{3}{8}$ in. thick. (6) A tension test showing the development of the Lüder lines.

Zoological Society, November 26.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—E. S. **Goodrich**: The structure of bone in fishes: a contribution to palæohistology. A microscopic examination of the bone of the Actinopterygian fishes showed that in those groups which are provided with lepidosteoid ganoid scales (Amioidei [Protospondyli] and Lepidosteoidei [Aetheospondyli]) the characteristic lepidosteoid histological structure extended throughout the endoskeleton as well as the dermal bones. No other fishes are known to have this lepidosteoid structure, either in the scales or in the skeleton.—G. W. **Smith** and Dr. E. H. J. **Schuster**: Land crayfishes of Australia. This paper dealt with the Engæus, a group of Victorian and Tasmanian crayfishes, which have forsaken the water and excavate burrows in damp soil. In certain mining districts on the west coast of Australia they do much damage to the artificial water-courses by riddling through the banks and dams and causing them to collapse. Although the tunnel leading to the heart of the burrow is free from water, there is always water in the circular chambers at the end where the crayfish lives. In a former paper it was suggested that these crayfishes of the genus Engæus are derived from the genus Parachæraps, which has spread from Western Australia into the desert regions of the centre, and is now found in all parts of continental Australia; but conclusive evidence is brought forward in this paper to show that Engæus is derived from the south-eastern and Tasmanian genus Astacopsis, and that its superficial resemblance to Parachæraps is due to convergence owing to similar habits.—Dr. C. L. **Boulenger**: The Myzostomida collected by Mr. Cyril Crossland in the Red Sea in 1905.—Hon. P. A. **Methuen**: Description of a new Amphipod, belonging to the family Talitridæ, obtained in the Woodbush district of northern Transvaal.—B. F. **Cummings**: Some points in the anatomy of the mouth-parts of the Mallophaga.

Geological Society, December 4.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—J. E. **Marr**: The Lower Palæozoic rocks of the Cautley district (Yorkshire). The succession in this district is clearer than in the Lake District, and it is suggested that it be adopted as the type sequence for the Ashgillian beds of the north of England.—E. S. **Cobbold**: (1) The trilobite fauna of the Comley Breccia-bed (Shropshire). A trilobitic fauna from the matrix of a breccia of Middle Cambrian age, found near Comley Brook, is described. The fossils indicate an horizon that is probably equivalent to a part of the Paradoxides-tessini zone of Scandinavia. As they are distinct from those of the Quarry-Ridge Grits of Comley, which are also basal but rest upon Lower Cambrian limestones, the inference is drawn that the two deposits are separated by a distinct interval of Cambrian time. (2) Two species of Paradoxides from Neve's Castle (Shropshire). Portions of two species of Paradoxides, collected in 1892 by Mr. J. Rhodes, are figured. These are referred to *P. hicksi*, Salter, and to a new variety of *P. bohemicus*, Bœck. Species of Agnostus, Ptychoparia (Liostracus), Agraulos, Hyolithus, and Acrotreta occur in the same rock-fragments, but are not sufficiently well preserved for specific determination.

Mathematical Society, December 12.—Prof. A. E. H. Love, president, in the chair.—Dr. H. F. **Baker** (retiring president): Presidential address on recent advances in the theory of surfaces.—H. E. J. **Curzon**: A connection between the functions of Hermite and those of Legendre.—G. H. **Hardy**: An extension of a theorem on oscillating series.—H. R. **Hassé**: The equations of the theory of electrons transformed relative to a system in accelerated motion.—E. W. **Hobson**: The convergence of series of orthogonal functions.—J. **McDonnell**: Mersenne's primes.—L. J. **Mordell**: The diophantine equation $y^2=x^3+k$.—

W. H **Young**: (1) Derivatives and their primitive functions. (2) Functions and their associated sets of points.

Royal Astronomical Society, December 13.—Dr. F. W. Dyson, F.R.S., president, in the chair.—Prof. H. H. **Turner**: Note on a new similarity between the variations of S Persei and of sun-spots. Prof. Schuster had shown that besides the well-known eleven-year period of sun-spots there are several other periods, viz. 4·77, 8·17, and perhaps one of 13·45 years; these seemed to be submultiples of a master period of $33\frac{3}{8}$ years. Prof. Turner had previously found a similar association of periodicities in the light curve of S Persei, which showed three independent periods, corresponding to sun-spot periods of 8·17, 11·13, and 33·38 years. The subject had now been more fully investigated, and satisfactory accordances obtained. In the discussion Prof. Schuster spoke of the sun-spot periods as 4·8, 13·5, 11, 8·3, and 48 years. Mr. Maunder and Father Cortie both doubted if these periods (with the exception of the 11-year) were more than mere arithmetical periods, having no real existence.—C. R. **d'Esterre**: Note on some observations of the region around the star clusters H v 33, 34 Persei. A series of photographs were taken with a 15-in. reflector with a view to answer the question, "What happens from night to night amongst the minute stars which form the general background of the Milky Way?" This led to the special selection of the well-known clusters in Perseus. The photographs were shown on the screen, and the results, in the discovery of new and variable stars, were described.—F. J. M. **Stratton**: Preliminary note on the later spectrum of Nova Geminorum, No. 2. Photographs shown on the screen gave the spectrum of the star—then of the eighth magnitude—and comparison spectrum on the same plate.—Prof. A. **Fowler**: Observations of the principal and other series of lines in the spectrum of hydrogen. The principal and sharp series of lines of hydrogen were observed by passing a strong discharge through a mixture of hydrogen and helium. Four members of the principal and three of the sharp series were identified, and their wave-lengths determined. They were found in satisfactory agreement with the corresponding lines in nebulæ and bright-line stars, &c. A second principal series was discovered, the first line of which was at wave-length 3203·30, the lines converging to the same limit as the first principal series.

DUBLIN.

Royal Dublin Society, November 26.—Mr. R. Lloyd Praeger in the chair.—Prof. J. **Wilson**: Unsound Mendelian developments, especially as regards the presence and absence theory. The purpose of the paper was to show that the presence and absence theory is unsound, that it leads to erroneous results, and that ordinary Mendelian formulæ suffice to deal with phenomena to which that theory has been applied. The theory originated in a misapprehension of experimental data. It was taken that when rose and single combs, and pea and single were mated, and the second crosses were rose and single, on one hand, and pea and single on the other in the ratio 3 : 1, the rose and pea combs were each the result of only one factor for each. It is shown in the paper that at least two factors are concerned in the production of roseness, on one hand, and peaness on the other, and that each of these two kinds of comb carries the results of at least four factors. The theory, as usually stated, is open to two interpretations. The usual interpretation is that a dominant factor is the cause of the dominant character, while the absence of the dominant factor is the cause of the recessive character. A cause which is absent is thus stated to have effect. But the absence of the dominant factor is really the cause of the absence of the dominant character, not the cause of the presence of the recessive.—A. L. **Fletcher**: A refined method of obtaining sublimates. The paper was a preliminary communication on an improved method of dry analysis. A support of electric arc carbon is enclosed in a sublimation chamber with removable silica or porcelain cover-plates, and is heated electrically. The advantages are the high temperature range possible and the facility with which high temperature work may be carried on in atmospheres other than air with the production of distinctive sublimates. The sublimation of certain substances on to existing deposits of iodine produces distinctive iodides on contact. A table was appended containing descriptions of sublimates obtained upon glass in air in sulphuretted hydrogen and on the iodine plate. It is possible to obtain, amongst others, deposits from vanadium, chromium, manganese, and iron.—A. L. **Fletcher**: The melting points of minerals. A short discussion of the principle of the meldometer was followed by a description of the methods followed in calibration. The facilities presented by the meldometer in the examination of very small quantities of substances were pointed out. Such are colour change, chemical change, reactions, fluxes. A table of the approximate melting points and behaviour at high temperatures of sixty of the rarer minerals was exhibited, together with a comparison of fusion temperatures arrived at on the meldometer and by non-subjective methods.

EDINBURGH.

Royal Society, December 2.—Sir William Turner, K.C.B., president, in the chair.—Sir William **Turner**: The right whale of the North Atlantic, *Balaena biscayensis*, its skeleton described and compared with that of the Greenland right whale, *Balaena mysticetus*. The description was based upon a specimen which had been presented to the Royal Scottish Museum by the manager of the sealing station on the west coast of Harris. This species of whale had been captured by Basque fishermen as early as the thirteenth century. It was believed to have become extinct during the eighteenth century, but in 1854 a specimen was caught off San Sebastian in Spain. Anatomical features showed that it was identical with *Balaena australis*, the whale of the Antarctic seas. As it is quite unknown in intermediate regions, it formed a good example of what has been called bipolarity.—Prof. A. H. **Gibson**: The loss of energy at oblique impact of two confined streams of water. The loss was shown to be expressible in the form $aV^2 + bv^2$, where V and v are the speeds of water in the main pipe and the inlet pipe respectively. The coefficients a and b, which are constant for any one pair of pipes, depend on the areas of section and on the angle at which the one pipe meets the other. It was found that the loss was least for a particular combination of area and angle.—Dr. J. **Ritchie**: The hydroid zoophytes collected by the British Antarctic expedition of Sir E. Shackleton, 1908.—Prof. D. **Hepburn**: Observations on the anatomy of the Weddell seal (Scottish National Antarctic expedition). Part IV. The brain. Among other results it was found that the adult brain has preserved and presents an early embryonic stage in which the lateral limbs of the fissure of Sylvius are held wide open by the failure of the opercula to conceal the insula.—Dr. H. A. **Haig**: The central nervous system of the Weddell seal (Scottish National Antarctic expedition). The general conclusion come to was that, both in its anatomy and in its histology, the Weddell seal showed some features which were retrogressive, and others which placed it at a much higher stage from the point of view of evolution.

PARIS.

Academy of Sciences, December 9.—M. Lippmann in the chair.—E. **Bouty**: An attempt at the determination of the dielectric cohesion of a rare gas with small quantities of material. An exact determination of the dielectric cohesion of a gas requires at least 200 c.c. of the material. An apparatus capable of dealing with as little as 5 c.c. of gas has been constructed. It requires empirical calibration with gases of known dielectric cohesion, and experiments have been carried out with neon, helium, and argon. The apparatus will prove useful in following the stages of purification of a rare gas.—L. **Maquenne** and E. **Demoussy**: The use of a manometer in the study of the respiration of plants. A description of a closed water manometer, independent of the barometric pressure, applicable to the qualitative study of plant respiration.—A. **Righi**: A new experiment on ionomagnetic rotations.—M. **Décombe**: The dissipation and discontinuity of energy.—J. **Taffanel** and H. **Dautriche**: The propagation of the explosive wave in solids.—M. **Lémeray**: A theorem of M. Einstein. The author shows that the total energy radiated by a symmetrical radiator is the same, whether it is displaced or not relatively to the observer. This result is not in accord with the conclusions of Einstein.—G. **Reboul**: The influence of the geometric form of solid bodies on the chemical actions which they undergo at low pressures. Details of experiments proving that copper when attacked by sulphur compounds at pressures of the order of 0·1 mm. in a manner depending on its geometrical form. The attack commences on those portions of the metal where the curvature is greatest.—R. **Swyngedauw**: The relation of the longitudinal ampere-turns to the moment of commutation in continuous-current dynamos.—A. **Cotton**: The optical properties of a liquid submitted to the simultaneous action of two electrical and magnetic fields, and on molecular symmetry. Attention is directed to the valuable results which would be obtained by a study of the optical properties of a liquid submitted simultaneously to the action of powerful magnetic and electrostatic fields. The chief difficulty would be the construction of the very large electromagnet necessary for such a study.—Pierre **Weiss** and Auguste **Piccard**: The magnetisation of water and of oxygen. The exact value of the coefficient of magnetisation of water has been determined by two independent methods with concordant results. The mean value is $\chi = -0{\cdot}7193 . 10^{-6}$ at 20° C., with a temperature coefficient of $+0{\cdot}00013$ in the neighbourhood of 20° C.—R. **Fortrat**: A new measurement of the magnetic decomposition of the lines of the second secondary series of zinc, and the quantitative verification of Preston's law.—Ch. **Féry** and M. **Drecq**: The diffusive power of platinum black and Stefan's coefficient. The method described gave a value of 0·82 for the coefficient of absorption of platinum black. From this, platinum black would not appear to be superior to lamp-black for use in absolute measurements of radiation.—M. **Tournier**: A method of measuring very great resistances. An electrometric method for resistances of the order of a megohm.—Jean **Meunier**: Some new forms of gaseous combustion in vortices and their analogy with the appearance of certain astronomical phenomena.—Ch. **Boulanger** and G. **Urbain**: The theory of the efflorescence of the saline hydrates.—A. **Colani**: The action of acids upon uranous oxide. The action of sulphuric and hydrochloric acids upon uranous oxide was found to depend very largely on the mode of preparation of the latter.—E. E. **Blaise**: Syntheses by means of mixed organo-zinc compounds. α-Polychloroketones. The constitution of ordinary trichloracetone.—J. B. **Senderens** and Jean **Aboulenc**: The esterification of the cyclanols by the aromatic acids. The catalytic esterification of the cyclanols, in presence of sulphuric acid, gives as good results with aromatic acids as with acids of the fatty series, provided that the carboxyl group is not directly united to the nucleus.—Raymond **Hamet**: The abnormal structure of the stem of *Rochea coccinea*.—L. **Blaringhem** and A. **Prévot**: Hybrids of wild and domestic guinea-pigs.—Raoul **Dupuy**: Contribution to the treatment of backward children by associated endocrinian extracts.—R. **Anthony** and L. **Gain**: The development of the skeleton of the wing in the penguin.—A. **Gruvel**: The anatomy of *Xenobalanus globicipitis*.—E. **Sollaud**: A new pœcilogonic variety of *Palaemonetes varians*.—E. **Fauré-Fremiet**: The action of the X-rays on the segmentation of the egg of *Ascaris megalocephala*.

NEW SOUTH WALES.

Linnean Society, September 25.—Mr. W. W. Froggatt, president, in the chair.—Cuthbert **Hall**: The Eucalypts of the Parramatta district, with description of a new species. Twenty-four species of Eucalypts are to be found in the area. Five are restricted mainly to the Hawkesbury Sandstone area, ten to the deep clay of the Wianamatta Shale Series, six to thin layers of clay overlying sandstone, two are uniformly distributed, and one grows in swampy ground. One species, which seems hitherto to have been confused with *E. tereticornis*, is described as new.—R. J. **Tillyard**: Some Australian Anisoptera (Neuroptera: Odonata), with descriptions of new species. The new species described are all distinct forms, including a new species of the genus Synthemis, from West Australia, a peculiar Austrogomphus, and a large Petalura. A study is made of the allied forms *Austroaeschna parvistigma*, Selys, and var. *multipunctata*, Martin, the conclusion being that these are distinct species.—R. T. **Baker**: Two unrecorded Myrtaceous plants from New South Wales. A Eucalypt collected at Black Mountain, New England district (C. F. Laseron), and a tea-tree (Melaleuca) from swamps on the Lawrence Road near Casino (L. G. Irby), are described as new. The former is locally considered to be a hybrid between the silver-top stringybark (*E. laevopinea*) and *E. stellulata*; in botanical sequence it may be placed between the stringybarks and the gums or smooth-barked Eucalypts. The Melaleuca finds its place in Mr. Bentham's Series v. (Spicifloræ) of the genus, next to *M. styphelioides*, Sm.

BOOKS RECEIVED.

Forty-first Annual Report of the Local Government Board, 1911–12. Supplement containing the Report of the Medical Officer for 1911–12. Pp. lxxx+366. (London: H.M.S.O.; Wyman and Sons, Ltd.) 3*s*. 8*d*.

A Laboratory Manual of Alternating Currents. By Prof. J. H. Morecroft. Pp. viii+247. (London: Longmans and Co.) 7*s*. 6*d*. net.

The Theory of Evolution in the Light of Facts. By K. Frank. With a chapter on Ant Guests and Termite Guests, by P. E. Wasmann. Translated from the German by C. T. Druery. Pp. xii+241. (London: Kegan Paul and Co., Ltd.) 5*s*. net.

Hazell's Annual for 1913. Edited by H. Hall. Pp. cxi+592. (London: Hazell, Ltd.) 3*s*. 6*d*. net.

Geometrical Optics. By A. S. Percival. Pp. vii+132. (London: Longmans and Co.) 4*s*. 6*d*. net.

God and the Universe. By G. W. de Tunzelmann. Pp. 256. (London: S.P.C.K.) 4*s*.

Outlines of the History of Psychology. By Prof. M. Dessoir. Authorised translation by D. Fisher. Pp. xxix+278. (London: Macmillan and Co., Ltd.) 7s. net.

Crops and Methods for Soil Improvement. By A. Agee. Pp. xv+246. (London: Macmillan and Co., Ltd.) 5s. 6d. net.

Monumental Java. By J. F. Scheltema. Pp. xviii+302+xl plates. (London: Macmillan and Co., Ltd.) 12s. 6d. net.

The Principia, or the First Principles of Natural Things. To which are added the Minor Principia and Summary of the Principia. By E. Swedenborg. Translated from the Latin by I. Tansley. Vol i., pp. cv+545; vol. ii., pp. xxi+669. (London: The Swedenborg Society.)

Cambridge County Geographies:—Linlithgowshire. By T. S. Muir. Pp. viii+142+2 maps. Rutland. By G. Phillips. Pp. x+171+2 maps. (Cambridge University Press.) 1s. 6d. each.

Problèmes d'Analyse Mathématique. By Prof. E. Fabry. Pp. ii+460. (Paris: A. Hermann et Fils.) 12 francs.

Leçons sur l'Intégration des Équations Différentielles aux Dérivées. By Prof. M. V. Volterra. Pp. ii+3+iv+83. (Paris: A. Hermann et Fils.) 6 francs.

Experimental Researches on the Specific Gravity and the Displacement of Some Saline Solutions. By J. Y. Buchanan. Pp. 227. (Edinburgh: Neill and Co., Ltd.) 7s. 6d. net.

Makers of British Botany. A Collection of Biographies by Living Botanists. Edited by F. W. Oliver. Pp. iv+332+xxvi plates. (Cambridge University Press.) 9s. net.

Changes in Bodily Form of Descendants of Immigrants. By Prof. F. Boas. Pp. xii+573. (New York: Columbia University Press; London: H. Frowde.) 7s. 6d. net.

The Writers' and Artists' Year-Book, 1913. Edited by G. E. Mitton. Pp. vii+147. (London: A. and C. Black.) 1s. net.

Who's Who, 1913. Pp. xxx+2226. (London: A. and C. Black.) 15s. net.

Books that Count. Edited by W. F. Gray. Pp. xx+315+lviii. (London: A. and C. Black.) 5s. net.

The Englishwoman's Year Book and Directory, 1913. Edited by G. E. Mitton. Pp. xxxi+412. (London: A. and C. Black.) 2s. 6d. net.

Einleitung in die Experimentalphysik: Gleichgewicht und Bewegung. By R. Börnstein. Pp. iv+118. (Leipzig: B. G. Teubner.) 1.25 marks.

Das Auge und die Brille. By Dr. M. von Rohr. Pp. vi+100+plate. (Leipzig: B. G. Teubner.) 1.25 marks.

School Gardening, with a Guide to Horticulture. By A. Hosking. Pp. xi+326. (London: W. B. Clive.) 3s. 6d.

A Barometer Manual for the Use of Seamen. Seventh edition. Pp. 83. (London: H.M.S.O.; Wyman and Sons, Ltd.) 6d.

Meteorological Office. Hourly Values from Autographic Records: Geophysical Section, 1911. Pp. 89. (London: H.M.S.O., Meteorological Office.) 5s.

Highways and Byways in Somerset. By E. Hutton. Pp. xviii+419. (London: Macmillan and Co., Ltd.) 5s. net.

Annals of the South African Museum. Vol. x., part iv., pp. 75–128; vol. x., part v., pp. 129–176+16 plates. (London: West, Newman and Co.) 2s. 6d. and 18s. respectively.

Records of the Geological Survey of India. Vol. xlii., part iii., 1912. Pp. 133–230. (Calcutta and London: Kegan Paul and Co., Ltd.) 1 rupee.

The Story of a Hare. By J. C. Tregarthen. Pp. xi+199+plates. (London: J. Murray.) 6s. net.

Vorlesungen über vergleichende Anatomie. 2 Lief. By Prof. O. Bütschli. Pp. iv+401–644. (Leipzig: W. Engelmann.) 9 marks.

Guide to the Materials for American History, to 1783, in the Public Record Office of Great Britain. Vol i., The State Papers. By Prof. C. M. Andrews. Pp. xi+346. (Washington: Carnegie Institution.)

The Crinoids of the Indian Ocean. By A. H. Clark. Pp. iii+325. (Calcutta: Indian Museum.) 20 rupees.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 19.

LINNEAN SOCIETY, at 8.—Experiments on the Pollination of our Hardy Fruits: C. Hooper.—The Morphology and Histology of Piper Betle, Linn: H. M. Chibber.—Some New British Plants: G. Claridge Druce.—Wild Rice, Annual and Perennial: Dr. Otto Stapf.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Work of the International Electrotechnical Commission: Dr. S. P. Thompson.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Dressing of Tin Ores in Cornwall: W. Fischer Wilkinson.—Notes on the Direct Volumetric Determination of Tin: H. J. B. Rawlins.—Notes on the Valuation of Nigerian Tin Concentrate: R. T. Hancock.

FRIDAY, DECEMBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Further Discussion:* Vapour-Compression Refrigerating Machines: J. Wemyss Anderson.—A Contribution to the Theory of Refrigerating Machines: J. H. Grindley.

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THURSDAY, DECEMBER 26, 1912.

AMERICAN ANTHROPOLOGY.

Putnam Anniversary Volume. Anthropological Essays Presented to Frederic Ward Putnam, in Honour of his Seventieth Birthday, April 16, 1909. By his Friends and Associates. Pp. viii + 627. (New York: G. E. Stechert and Co., 1909.)

THIS is a spacious, richly illustrated volume, finely printed on Normandy vellum, consisting of twenty-six valuable contributions to anthropological knowledge, a noble tribute in substance and form rendered by friends and associates to a master. To the true master nothing could be more delightful than an exhibition of excellent work done by those who live in his light and follow his leading. Few and brief are the biographical and eulogistic remarks about the recipient of this magnificent birthday present, but one feels his presence throughout the book, and no formal eulogy could have been more eloquent than the last paper in the series, "Bibliography of Frederic Ward Putnam," by Frances H. Mead. In addition to very extensive "Editorial Labours," a list is given of 404 items of publications. *Si monumentum requiris, circumspice.*

The papers are formal scientific reports, and a bare list of titles and authors should serve a useful purpose:—The archæology of California, by A. L. Kroeber; ancient Zuni pottery, by J. Walter Fewkes; pottery of the New England Indians, by Charles C. Willoughby; the Seip mound, by William C. Mills; the fish in ancient Peruvian art, by Charles W. Mead; a study of primitive culture in Ohio, by Warren K. Moorehead; cruciform structures of Mitla and vicinity, by Marshall H. Saville; conventionalism and realism in Maya art at Copan, with special reference to the treatment of the macaw, by George Byron Gordon; the exploration of a burial room in Pueblo Bonito, New Mexico, by George H. Pepper; tribal structure: a study of the Omaha and cognate tribes, by Alice C. Fletcher; the dates and numbers of pages 24 and 46 to 50 of the Dresden codex, by Charles D. Bowditch; notes on religious ceremonials of the Navaho, by Alfred Marston Tozzer; certain quests and doles, by Charles Peabody; a curious survival in Mexico of the use of the Purpura shellfish for dyeing, by Zelia Nuttal; Gotal, a Mesalero Apache ceremony, by Pliny Earle Goddard; the Cayapa numeral system, by S. A. Barrett; stature of Indians of the south-west and of northern Mexico, by Aleš Hrdlička; notes of the Iroquois language, by Franz Boas; outlines of Wintun grammar, by Roland B. Dixon; a new Siouan dialect, by John R. Swanton; primitive industries as a normal college course, by Harlan I. Smith; a visit to the German Solomon Island, by George A. Dorsey; the Pillars of Hercules and Chaucer's "Trophee," by G. L. Kittredge; notes on the Irish practice of fasting as a means of distraint, by F. N. Robinson; Dusares, by C. F. Toy; and the bibliography already mentioned.

It is very curious that with one exception the authors avoid the important matter of pre-Columbian periods and dates. They give excellent measures and oriented plans, with scarcely a word to show why such measures should be carefully made at all. The British archæologist thinks first and foremost of dates; in America the whole subject seems to be left very much in abeyance. About the only reasoned estimate of pre-Columbian times is given in the paper on primitive culture in Ohio. There three distinct types of culture have been made out, one of which is thought to be "at least eight hundred years old" (p. 147). The author remarks: "The natural history method applied to a study of these sites will go far towards establishing their age." This reveals "the open mind." On the whole, the restraint exercised by the writers in the matter of time-measuring is a very hopeful sign, and when Americanists will seriously consider the meaning of the coincidences and harmonies which lie on the very surface of most of the papers in this volume, their treatment of the facts will be as unhampered by badly informed traditions as that of the present facts discussed certainly is.

There are here and there some misprints, and there is one very serious defect to be mentioned. Here lies buried in Normandy vellum an encyclopædic mass of fresh facts of the utmost value, with slight hope of a resurrection. A quarto volume of more than 600 pages without an index!

JOHN GRIFFITH.

CERAMIC CHEMISTRY.

Ceramic Chemistry. By H. H. Stephenson. Pp. vii+91. (London: Davis Bros., 1912.) Price 6s.

EVERYONE interested in the science of pottery manufacture will welcome the appearance of this little handbook. Mr. Stephenson is known to be a practical pottery chemist, and should, therefore, be competent to remove the reproach often made against the English that they have contributed little or nothing in the way of scientific text-books dealing with the practical side of pottery, though France, Germany, and the United States have each in turn shown great activity in this special department of work.

We must, however, confess to a little disappointment with the work, for, instead of a reasoned, adequate discussion of the many problems which beset the potter such as we had a right to expect, it proves to be a reprint, almost without alteration, of a series of articles that appeared rather more than a year ago in the columns of a trade journal. Perhaps it is for this reason that the volume resembles far too much the mere note-book of a diligent student, valuable in its way as a record of salient points and of the latest published work, but more valuable to the writer than to the reader.

We may mention as an example the opening paragraph of chapter ii. :—

"There are numberless varieties of clay, but it [*sic* !] may roughly be divided into ball clay, china clay, and fireclay; or, in other words, plastic clay, non-plastic clay, and refractory clay."

This is certainly very curious information for a potter, considering what a large part the ordinary surface clays of all countries have always played, and still play, in practical work. It is only the modern English earthenware manufacturer who could possibly conceive that such a statement was even approximately true.

On p. 13 we find the statement that "Two properties of clay—plasticity and cleavage—are of prime importance to the potter." Plasticity we understand, but that the cleavage of clay has anything to do with the potter is certainly not proved in the pages of the book.

One might criticise in the same way the chapters dealing with "glazes" and "enamels," where a number of statements are made as if with authority, though, to say the least, they are exceedingly dubious.

In the same way the chapter on industrial diseases does not merit its place, for if it were a true statement of the facts of the case the manufacturers have no defence to offer, whereas it is well known that there are the greatest practical difficulties in adopting the solution of the problem recommended, viz., the use of lead silicates of low solubility in dilute acid mixtures. Mr. Stephenson remarks that "the problem is one of ways and means, the chemistry of the subject being fairly simple." Certainly, for this is only another way of saying that the theory is very simple, but the practice happens to be difficult.

W. B.

TWO BOOKS ON HEREDITY.

(1) *Heredity and Eugenics.* A Course of Lectures Summarising Recent Advances in Knowledge in Variation, Heredity, and Evolution, and its Relation to Plant, Animal, and Human Improvement and Welfare. By William Ernest Castle, John Merle Coulter, Charles Benedict Davenport, Edward Murray East, William Lawrence Tower. Pp. vii+315. (Chicago: University of Chicago Press; London: Cambridge University Press.) Price 10*s.* net.

(2) *Richtlinien des Entwicklungs- und Vererbungsproblems.* By Dr. Alfred Greil. Zweiter Teil: Anpassung und Variabilität, Ererbung und Erwerbung, Geschlechtsbestimmung. Pp. iii+364. (Jena: Gustav Fischer, 1912.) Price 10 marks.

(1) "HEREDITY and Eugenics" consists of a series of lectures delivered at Chicago in 1911 by five of the best-known American students of the subject. It deals with plants, animals, and man, and is intended as a popular exposition of recent advances of our knowledge of heredity. The lecturers had evidently not consulted each other with regard to the parts of the subject to be dealt with by each, with the result that there is some overlapping, but in a book intended for those who have made no serious study of the problems involved, this is not a serious disadvantage. All the chapters are simply and clearly written, and the book is well illustrated with excellent figures. In general the cases chosen are well suited to the purpose, and for the untrained reader the book will give a clear idea of the present state of our knowledge and of its bearing upon practical problems.

The student who has attempted to keep abreast with recent work will find very little that is new to him; everything has been already published elsewhere, usually in an accessible form. To the trained biologist the long chapter by Prof. Tower will probably appear the most interesting; it is in parts difficult to follow, but gives a very useful summary of his large work on variation in Chrysomelid beetles, which to many is probably known only from reviews and abstracts.

The book as a whole appears to us to suffer from one rather serious defect—the dogmatic style in which most of the chapters are written. For a popular audience it is doubtless necessary to be as definite as possible, and to avoid undue emphasis on apparent exceptions which are really easily explicable. But the writers of this volume seem to carry this principle to lengths which may be absolutely misleading, and to confuse fact and inference in a way which almost inevitably tends to the discredit of the subject. In Prof. Tower's chapter this tendency shows itself chiefly in his references to the faulty methods of other investigators (Kammerer, Woltereck, Sumner, and others are mentioned in this connection), although no clear statement is given as to where the fault lies. The objections may be sound, but it is scarcely fair thus to impugn the accuracy of the work of others without making it quite clear in what the inaccuracy consists.

In some of the other chapters the dogmatic attitude appears rather in the form of leading the reader to believe that problems are completely understood when, as a matter of fact, many points with regard to them remain obscure. This is exemplified in Prof. Castle's short account of sex-determination in Rotifers and Daphnids, and more seriously in some of Prof. Davenport's statements about the inheritance of certain characters in man. That the statements are made in a more definite form than is justified by the known facts is doubtless explained by the necessity of making them clear and impressive to an untrained audience, but it is unfortunate that in preparing the lectures for publication more care was not taken to differentiate between facts which are absolutely known, and inferences which do not as yet admit of rigid proof.

In conclusion, it should be mentioned that the last two chapters include a couple of slips which might mislead the reader: on p. 277 *diabetes insipidus* (which appears to be confused with the common diabetes) is correctly placed among abnormalities which appear to be dominant, but it is stated that two normal parents may have defective children; and on p. 286 the statement is made with regard to recessive abnormalities that "two affected parents have exclusively normal children," where affected children is, of course, meant.

(2) Prof. Greil's book is of a very different character. It is an attempt to show that all the phenomena of development, inheritance, and sex-determination can only be properly considered from the point of view of epigenesis. The word "epigenetisch" appears on almost every page, and much dialectical skill is expended in showing that cases in which some form of predetermination appears to be the natural explanation are really epigenetic in character. The motto of one of the chapters—

> "Was du ererbt von deinen Vätern hast,
> Erwirb' es, um es zu besitzen,"

is the central theme of the book—that the germ only receives inherited tendencies, and that these cannot be studied apart from the manner and conditions of their development. In general, this is of course true, but in his treatment of it the author will seem to many readers to carry his thesis to extreme lengths. Since the development of an inherited tendency is a physiological process, it should theoretically be possible to induce a similar physiological process without any inherited tendency; therefore the inheritance of acquired characters must be possible in certain cases. Although in some cases the presence of a specific sex-chromosome causes the individual to become of one sex, in the absence of a sex-chromosome influences which bring about the same physiological condition in embryonic life will also cause it to be of that sex. Telegony must exist, because the bearing of young of a different breed must cause the mother to become "in a certain sense a hybrid." The whole hypothesis of Mendelian factors must be given up because it savours of preformationism rather than epigenesis. To summarise chapters in sentences of this sort is perhaps scarcely doing the author justice, but they give a fairly accurate idea of his attitude.

The book suffers from the absence of headings to chapters or paragraphs; there is no table of contents and an entirely inadequate index, so that it is very difficult to find out in what part of the book any given subject is treated. The style also is overloaded and difficult to follow. The last 130 pages are devoted to a critical account of theories of heredity, closely printed in exceedingly small type. L. DONCASTER.

PHOTOGRAPHIC ANNUALS.

(1) *The British Journal Photographic Almanac and Photographer's Daily Companion*, 1913. Edited by George E. Brown. Pp. 1448. (London: Henry Greenwood and Co., n.d.) Price: cloth, 1*s*. 6*d*. net; paper, 1*s*. net.

(2) *The American Annual of Photography*, 1913. Edited by Percy Y. Howe. Pp. 328. (New York: George Murphy, Inc., 1912.) Price 75 cents.

(1) ABOUT this time of the year nearly every photographer places on his bookshelf the 1912 edition of his B.J. Year Book, probably well ear- and thumb-marked, and becomes possessor of the 1913 issue, a volume of about equal size and weight. The current work, which is the fifty-second issue, covers 1448 pages, but of these about two-thirds are advertisements, and, as experience has shown, are most useful to both professional and amateur photographers. While the general contents of this well-known annual need no special reference, some notable items in the present issue deal with the important subject of the fitting up of the dark-room by the editor, an excellent and thoroughly practical article on methods of telephotography by Capt. Owen Wheeler, and 120

hints in picture form of "how to do it," being a useful set of wrinkles for the beginner.

Space does not allow us to do more than name such useful items as the year's progress, working formulæ, tables of various kinds, &c., as are brought together in this storehouse of photographic information. Excellent indices make it quite easy to find anything contained in the volume, and the usual price of one shilling makes the issue available to everyone.

(2) The second book has for its object the presentation of a selection of articles on current photographic topics combined with reproductions of numerous specimens of photographic work.

The editor evidently had a very large amount of material to handle, and his selection contained in this volume should meet the requirements of most photographers. The list of contributors is quite large, and the subjects dealt with exceedingly varied, so that the volume forms a series of short essays on many very useful hints in different branches of the subject. The illustrations are good throughout, and the frontispiece is a fine reproduction on buff linen. The last portion of the book is devoted to a typical collection of formulæ and tables selected from the working methods of practical photographers.

OUR BOOKSHELF.

Studies in Light Production. By Dr. R. A. Houston. Pp. iii + 115. (*The Electrician* Series.) (London: *The Electrician* Printing and Publishing Co., Ltd., n.d.) Price 5*s*. net.

THE publication in one volume of Dr. Houstoun's papers on artificial illumination will be welcomed by all those interested in that subject. The collection consists of ten chapters which have appeared in *The Electrician*, together with two others. It may at once be said that the contents are not only extremely interesting, but will also serve as a useful and important handbook for lighting engineers.

The intention of the author has been to collect information respecting the various illuminants at present in use for purposes of comparison and with the view of suggesting the lines upon which future progress may be made. Thus we find following the first two chapters (which are devoted to the consideration of the energy spectrum and the black body) a chapter on each of the following light sources: flames, the Welsbach mantle, the carbon glow-lamp, the arc, the Nernst lamp, metallic filament lamps, and the mercury arc. Comparisons of the luminous and radiant efficiencies are given, showing how great improvements in these have been made in recent years. In chapter x. the author discusses the question of the light of the future particularly with reference to the possible use of vacuum tubes containing nitrogen, or, according to Claude, neon by preference. Some very striking figures are given which certainly seem to indicate the probability of great saving of energy by this mode of lighting. Attention is also given to fluorescence, and, although the author advises caution in this case, this also may some day be used.

Chapter xi. is a reproduction of Dr. Houstoun's Royal Society paper on the absolute measurement of light, the proposal being to measure light by means of a thermopile which receives the energy surviving the passage through a suitable filter, *i.e.* one which cuts off the infrared and ultraviolet and is transparent to the various luminous radiations in proportion to their visibilities. Since, however, the data required for this can only be obtained by visual observation, this light measurer is not really independent of the human eye, and therefore scarcely surmounts the colour difficulties experienced in ordinary photometric measurements.

Modern Mine Valuation. By M. Howard Burnham. Pp. xi + 160. (London: Charles Griffin and Co., Ltd., 1912.) Price 10*s*. 6*d*. net. (Griffin's Mining Series.)

IN this book the author discusses the fundamentals of mine valuation—a subject too seldom ventilated and too little introduced into the training of mining engineers.

The subject is treated mathematically. The less secure an investment, the greater the interest required; the less an ore-body is disclosed, the greater the insecurity and the greater the interest demanded. According to the author, every occurrence of ore, whether it be but an outcrop untouched or whether it be an underground block honeycombed with exposures, may, by the application of a "risk rate" especially applicable to its condition, be valued mathematically and logically. The descriptions of "positive," "probable," and "possible," as applied to statements of ore-reserve, disappear by this method; each block becomes rated at a present value corresponding to the rate of interest demanded by its sufficiency or insufficiency of exposure. Into this calculation, also, deferment is entered until the mathematical formulæ will overwhelm the mining engineer who took to mining under the idea that observation was the one important faculty to cultivate.

The procedure in calculating the results of sampling is also carefully discussed, and towards the end many useful tables of present values, at various rates of interest, are given. Most of the first portion of this book appeared in *The Mining Magazine* late last year, when its value was increased by the discussion forthcoming from various engineers.

Although some of the views expressed and the novel mathematical treatment may not command entire agreement from his colleagues, they are all assured that his work can only result in putting the purchase and sale of mines upon a more logical footing. A careful reading of this book, though it may be hard to many, will be of interest and benefit to mining engineers generally, each of whom, at some time or another, will find application for some of the points elaborated.

S. J. TRUSCOTT.

Wimbledon Common: its Geology, Antiquities and Natural History. By Walter Johnson. Pp. 304. (London: T. Fisher Unwin, 1912.) Price 5s. net.

THE natural history—using the term in its widest sense—of any restricted area has a charm of its own, though it may appeal but to a limited number. A thorough study of the geology, antiquities and natural history of a district is a valuable piece of education, somewhat akin to the study of "types" in biology, and anyone who has pursued such a course will have his interest stimulated, and be in a far better position to enjoy the charms of his own or of a foreign country than had he not done so.

The present book deals with Wimbledon Common, a stretch of moorland and wooded country, in the heart of which it is difficult to realise that Whitehall is but half-a-dozen miles or so distant. An interesting account is given of the geology, botany and zoology of the district, and the antiquarian and historical sides are well done. We have a personal acquaintance with the common and can testify to the general accuracy of the book, and the perusal of it has added much to our knowledge of the district. Mr. Johnson expresses the hope that his chapters may be of service in the cause of "nature study," and we can cordially recommend it for such a purpose. The book is well illustrated with a number of plates and drawings and four maps. R. T. H.

Telephotography. By C. F. Lan-Davis. Pp. xi + 130. (London: G. Routledge and Sons, Ltd., n.d.) Price 2s. net.

THE getting of a large enough image of distant objects, or of near objects without an unpleasant proximity to them, is a difficulty that often presents itself to the photographer. A lens of greater focal length is theoretically serviceable in such cases, but the long camera that it would require may not be available, and if provided would often be troublesome to manipulate. This accounts for the popularity of telephotographic lenses. Some of them have the positive and negative elements fixed with regard to each other, and then they differ little, if at all, in their use from lenses of the ordinary simple type. But when the two elements are adjustable with regard to each other, in order to allow of obtaining various sizes of the image, many new problems arise. We therefore welcome this little volume, in which these problems are dealt with in a practical and very concise manner.

The book includes some remarkable illustrations, such as a photograph of Mount Kenya, in British East Africa, taken from a distance of ninety miles, while at the other extreme as to distance is a photograph of an Emperor moth about life size. A short chapter on "telephotomicrography" deals with an application of these lenses that is too often neglected. The magnification conveniently obtainable with instruments at present on the market is always very low, the advantage being in the greater distance between the lens and the object, which improves the perspective and facilitates the lighting.

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.*]

The Natural Fracture of Flint.

SIR E. RAY LANKESTER, K.C.B., in his learned and comprehensive article in NATURE of November 21, has suggested the various lines of research which it will be necessary to follow if a thorough-going knowledge of the mode of origin, structure, and fracture of flint is to be obtained.

The first two, which are intimately associated with the sciences of chemistry and physics, I am, owing to a lack of knowledge of these subjects, unable to deal with. But having for some time past carried out a series of experiments with flints subjected to natural percussion and pressure, I have been able to discover certain facts which I think may interest prehistorians, and help them to decide with more certainty what is human flaking upon any given stone, and what is not.

In order to provide conditions in which flints would strike each other fortuitously, I could think of no better plan than to get a large sack, and, placing eight or nine stones in it, shake it violently about for some considerable time, and afterwards observe whether any of the flints had been flaked in the process.

For my experiments with pressure I used a converted letterpress and a differential screw-press, with which very considerable pressures were obtained.

The rudimentary character of these appliances may be used by some as an argument against the value of the results obtained, but it seems to me that the nature of a blow does not differ whether it is delivered in my sack, or on a sea-beach, or in a fast-running river. In the same manner, pressure is pressure, whether applied in my presses or under a mass of gravel, ice, or other weight of material.

Moreover, I have noticed that stones found on sea-beaches which have been flaked by the action of the sea exhibit the same characteristics as those resulting from my sack experiment, and I think that the flaking on my specimens will be found to be in accord with that of any stones from any geological deposit which can be proved to have been flaked by fortuitous blows or pressure.

I propose now to give a description of the flaked specimens resulting from my experiments, and to show how, in my opinion, they differ from flints found in various pre-river-drift deposits, and which I and others look upon as having been flaked by man.

I will deal first with those chipped by fortuitous blows in my sack experiment.

(1) Flaking was produced upon stones which were more or less of a wedge shape, the thinnest end of the wedge being that from which the flakes were removed.

In the deposits which we examine we find that the flaked flints are of all and every shape, and this leads us to conclude that man has been the fracturing agent.

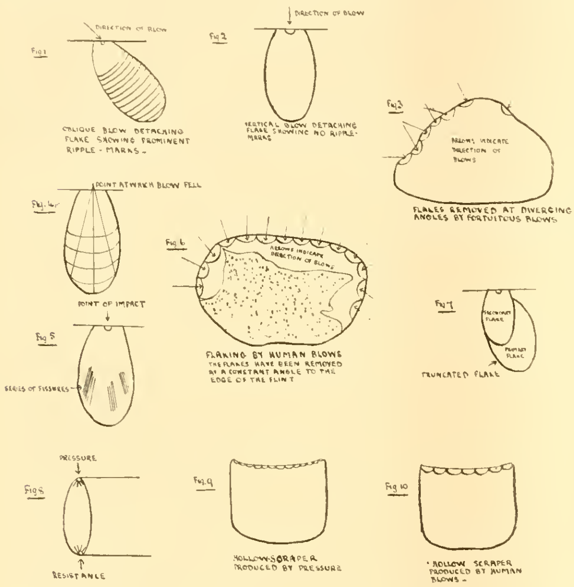
(2) The large majority of the fortuitous flakes were short and cut deeply into the stone, showing that the blows which caused their removal had impinged almost directly upon the edge itself. This opinion is supported by the fact that the edge is blunted where blows have fallen upon it.

The large majority of the flakes which have been removed from the stones considered to be human are, in the first place, differently formed and longer, and were evidently detached by blows delivered *on the side of the edge.*

When flaking flints I find that it is only this type of blow which will produce a sharp cutting edge; I conclude that these were flaked for that purpose, and consequently that they have been fabricated by man for some cutting or scraping purpose.

(3) The fortuitous flakes also nearly always show on their surfaces prominent undulations or ripple marks, caused by the fact that they were detached by blows which struck the edge obliquely (Fig. 1).

As there are 180 angles at which a flake can be removed from the edge of a flint, and as it is only the higher angles which will remove flakes showing no ripple-marks, it is seen that nature has many more chances of delivering oblique blows which detach flakes showing this peculiarity. Observations have shown that as the obliquity of the blow increases or decreases, the visibility of the ripple-marks increases



or decreases. It has been found that to detach a flake obliquely is a very difficult task, and that generally in doing so several blows have to be delivered which have the effect of shattering and blunting the edge which is being produced.

It is, however, a very easy matter to detach flakes by *vertical* blows (Fig. 2), and, moreover, by so doing an excellent sharp edge is formed. As the flaked flints I find have been flaked by vertical blows, I conclude that man has been the fracturing agent.

(4) It was also noticed that the fortuitous flakes had been removed by blows falling at different angles to the edge of the stone (Fig. 3).

The method I adopt to arrive at the angle at which the blow fell which detached any particular flake, if the actual bulbar cavity is not visible, is to draw a line down the centre of the flake and at right angles to the ripple-marks, and then to draw two others on each side of and equidistant from the centre one, and also at right angles to the ripple-marks as they curve upwards (Fig. 4).

These three lines must then be continued out until they meet, and the point of juncture will be found to be the spot where the blow fell which detached the flake. The other method is to examine the surface of the flake for those small fissures which result from a blow and "fan out" from the point of impact (Fig. 5).

The flints considered to be "human" show that the flakes have been removed at a *constant* angle to the edge of the flint, and by flaking stones I find that this must of necessity be so (Fig. 6). To try to put an edge on a flint by blows delivered at different angles would be a very troublesome and useless procedure. I also found that the flaked edges of the flints produced in my sack experiment showed a large number of truncated flakes. On one specimen I counted seventeen on one edge $4\frac{1}{2}$ in. long. These truncated flakes are those which have got diminished in size or cut off by the later flaking of the edge (Fig. 7).

In my sack experiment, where the rain of blows is practically continuous, the edge of the flint is continually being re-flaked, and in consequence truncated flakes are formed. On the other hand, the stones I look upon as having been humanly struck do not show many truncated flakes, and, as when flaking flints myself I find it is not necessary to make many such flakes in forming a cutting edge, I conclude that man has been the fracturing agent in the case of these specimens.

In nearly every flint which I have flaked by fortuitous blows I find that a distinct sinuous edge, similar to that seen upon many Palæolithic and Neolithic implements, is produced, and at first sight might lead to the conclusion that nature can exactly imitate man's work, but an examination of the details of the individual flakes, such as I have outlined above, at once shows that this is not so.

I will now give the results of my experiments with flints under pressure.

(1) I find that when a flint is placed upon the hard floor of the press, and a large amount of pressure exerted upon it with the ram, it will break in half, and that the broken surface exhibits two bulbs, at each point where pressure and resistance acted (Fig. 8).

The bulb which is formed on the side of the flint resting on the floor of the press is always more prominent and better formed than that at the opposite side, where the ram impinged. I am, however, unable at present to say why this should be so. None of the flaked flints found in the pre-river-drift deposits show these two bulbs, and I therefore conclude that man has produced them, because it is impossible to form two such bulbs on one flake by detaching it with a blow.

(2) It was found that if a folded duster or piece of cloth was placed upon the floor of the press, thus giving the flint a soft base upon which to rest, with greater pressure than was needed in the former case, a flake was detached showing only one bulb. This bulb, however, is of a different character from one produced by a blow, being flat and only partly developed, and as I do not find such bulbs on the flints we look upon as "human," I conclude that man

produced those showing on these latter specimens (that is, of course, when they have obviously not been detached by fortuitous blows).

(3) I find that by bringing pressure to bear upon a flint with a sharp edge resting upon a rounded pebble a "bay" can be produced upon the uppermost stone which has the appearance of a "hollow scraper" made by man.

By carefully watching one of these sharp-edged stones in the process of being flaked, it was seen that so long as the pressure was applied the flaking was continued.

The flint was evidently breaking along the lines of least resistance, and very thin flakes being removed, the hollow produced having a totally different appearance from one made by blows.

The reason for this difference was seen to be owing to the fact that as it is impossible to strike the flint near enough to its edge to remove flakes as thin as are detached by pressure, the hollow scraper produced by blows has a rougher appearance because each individual flake has cut deeper into the flint (Figs. 9 and 10). The hollow scrapers which are derived from the pre-river-drift deposits have obviously been produced by blows, delivered at a constant angle to the edge, and it is therefore concluded that man has made them.

It is, of course, possible that these early men in some cases may have edge-flaked their flints by pressure applied with another stone or a bone point, as the later Neolithic people did, but it does not seem likely that this was the case. Experiments were conducted with flint flakes covered by an inch or inch and a half of fine sand in an iron dish, and it was found that the greatest pressure obtainable with the differential screw-press was unable to break them.

A similar experiment was also conducted under the same conditions except that no iron dish was used and the sand was allowed to flow under the pressure. Here again, however, no fracturing of the flint took place. I think these results should induce caution in asserting that large stones lying under many feet of fine sand have been broken by pressure. I found that with pressure-flaking the small fissures in the flint, which are so common in flaking by percussion, are very rare, and I think this is due to the different methods of fracture. Also the surface of a pressure-flake is very seldom so glossy as that produced by a blow, which fact can perhaps be explained on the same hypothesis.

I may say that my experiments were carried through a great number of times with all sorts of flints, and the same results obtained.

In conclusion, I would like to state that specimens demonstrative of all the foregoing experiments are housed in the department of ethnology of the British Museum (Bloomsbury), and can be seen and handled by anyone who wishes to do so.

J. Reid Moir.

12 St. Edmund's Road, Ipswich, November 25.

Excitation of γ Rays by α Rays.

In a paper shortly to be published in *The Philosophical Magazine*, one of us has shown that when the α rays from radium C impinge upon matter, they excite a small but detectable amount of γ radiation. In continuation of this work a systematic investigation of the radiations from bodies which expel α rays has been commenced. So far the radiations from ionium, radio-thorium, and radio-actinium have been investigated. Working with a very strong source of ionium, we find that, after all radio-active products likely to emit β or γ rays have been removed by chemical treatment, ionium emits, in addition to its α rays, a certain amount of γ radiation, but no detectable amount of β radiation. The amount of γ radiation compared with the total α radiation is much smaller than that emitted by a typical γ ray product like radium C. The amount, however, is of about the same order as that excited by the α rays of radium C in external matter. Since there is no evidence of the existence of a product accompanying the ionium and emitting γ rays only, it is natural to suppose that these γ rays are excited either in the ionium, or in the thorium which is mixed with it, by the α rays.

Analysis of this radiation by means of absorption measurements gave the interesting result that it consists of three types at least. The least penetrating of these consists of a radiation, the absorption coefficient divided by the density (μ/D) of which has a value in aluminium of about 400 (cm.)$^{-1}$, the second of about 8·2, and the third type, which has not been investigated in detail owing to the weakness of the source, of about 0·15, *i.e.* it is of about the same order of penetrating power as the hard γ rays from radium C, viz. 0·04. It will be noticed that the second type has approximately the same value of μ/D as the characteristic radiation of series L excited by X-rays in thorium, as found recently by Chapman. It is therefore natural to suppose that all three types are characteristic radiations of ionium of different series.

We find also that radio-thorium emits γ rays, and also a small amount of β radiation. This radiation has not been studied in as much detail, owing to the rapid formation by the radio-thorium of thorium X and subsequent products, expelling intense β and γ rays. The ratio of the amount of γ to α radiation emitted by radio-thorum is approximately the same as the corresponding ratio for ionium.

The results obtained with radio-actinium, which is the product in the actinium series corresponding to radio-thorium in the thorium series, and to ionium in the uranium series, are very different. Dr. Hahn has shown that radio-actinium emits, in addition to α rays, some soft β rays, and also a radiation which is either a hard β or a soft γ radiation. We have repeated his work, and find that it expels, in addition to soft β rays, γ radiation of two types, the more penetrating of which is of the same order of penetrating power as the hard rays from radium C. The amount of β and γ radiation emitted by radio-actinium, however, is much too large to be ascribed to α rays alone.

It has hitherto been supposed that radio-actinium is a single product, having a period of 19·5 days, but we have succeeded in showing that it consists of two successive products. The parent product has the period of 19·5 days, as found by Hahn, and emits little or no penetrating β or γ radiation, and very probably no α rays. The second product expels α, β, and γ rays, and has a period of about thirteen hours. So far we have not succeeded, by means of a single chemical operation, in separating completely one product from the other, but, by means of a series of operations, we have been able to obtain a fraction of either product free from the other. It is of interest to note that Dr. Geiger and Mr. Nuttall predicted, from their well-known relation between rate of transformation and range of α rays, that radio-actinium probably consists of two successive products, the first of these having the period of 19·5 days, as found by Hahn, and the second giving the α rays and having a period of about one day. It is seen that this prediction was surprisingly accurate.

We intend to continue this work by investigating the γ and β radiations expelled by intense sources of radium, polonium, thorium X, and other α ray products.

J. Chadwick.
A. S. Russell.

Physical Laboratories, Manchester University, December 16.

The Prickly Pear in Western China.

MR. F. KINGDON WARD, in a very interesting paper in *Annals of Botany*, October, 1912, describes the occurrence of the prickly pear in the arid regions of western China. He states that it grows on granite rocks, and he has traced it from Kansu through Ssŭ-chuan to south-eastern Tibet and southern Yunnan. He is not able to determine precisely how it got there, but "two suggestions present themselves—the first that it was brought across the Pacific by the Chinese themselves, the second that it was introduced from Europe after it had been brought into the Mediterranean region from across the Atlantic; a third alternative, that it was quite recently introduced by the Jesuit missionaries who came from America to China about the time of the fall of the Spanish Empire, is hardly tenable in view of its present wide distribution in western China." He adds: "There can be little doubt that the Chinese visited California long before Columbus or possibly even the Norsemen discovered America."

Mr. Ward states that the species is *Opuntia vulgaris*, but it seems doubtful whether he critically examined it. If specimens were preserved, the determination of the species would help to decide the question of its origin. The original *Opuntia vulgaris* is the common plant of the eastern United States, which is not likely to have reached China by any of the means suggested. Probably *Opuntia ficus-indica*, sometimes called *O. vulgaris*, is the plant intended. This is the tropical American species, naturalised in the countries bordering the Mediterranean. A plant brought from California would be different, perhaps *O. littoralis*, which is so abundant along the coast of southern California. Would this or *O. ficus-indica* grow in western China and Tibet? Perhaps some more northern plant is represented. In any event, the precise determination of this Chinese cactus would be of much interest.

T. D. A. COCKERELL.

University of Colorado, Boulder, December 2.

ANTHROPOLOGY IN INDIA AND MALTA.[1]

(1) THIS is one of the excellent monographs on the wilder tribes of eastern India which were started by the Government of Eastern Bengal. It may be hoped that the recent changes in the provincial jurisdiction will not interfere with the completion of this project. The present volume is written by an officer who possesses the indispensable qualification of an intimate knowledge of the people. He gracefully dedicates it to Lieut.-Col. T. H. Lewin, whose valuable works have been the standard authority on the people of this district. There is some difficulty about the nomenclature of these tribes, because the terms Kuki, Naga, Chin, Shendu, and many others are not recognised by the people to whom we apply them. Kuki, however, has come to possess a

Photo] [*Lt.-Colonel H. G. M. Cole, I.A.*
FIG. 1.—A rest by the way—on the way to the Jhums. Lushais and Pois. From "The Lushei Kuki Clans."

[1] (1) "The Lushei Kuki Clans." By Lieut.-Col. J. Shakespear. Pp. xxiii+250. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* net.
(2) "From the Black Mountain to Waziristan." By Col. H. C. Wylly, C.B. With an Introduction by Lieut.-General Sir H. L. Smith Dorrien, K.C.B., D.S.O. Pp. xx+505+viii maps. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* 6*d.* net.
(3) "Malta and the Mediterranean Race." By R. N. Bradley. Pp. 335. (London: T. Fisher Unwin, 1912.) Price 8*s.* 6*d.* net.

fairly definite meaning as applied to certain closely allied clans, with well-marked characteristics, belonging to the Tibeto-Burman stock. The name Lushai, which we also use in a somewhat vague, ill-defined way, is an incorrect transliteration of Lushei, the name of a single clan. In this monograph Lushai is used in the wider sense, Lushei being restricted to the clan of that name.

Beginning with a complete bibliography of the published literature, the book follows the order prescribed for the other volumes of the series, with chapters descriptive of the domestic life, laws and customs, religion, folk-lore, and language of the allied groups. It is provided with an excellent collection of photographs, some coloured, with a map and good index. On the whole, the execution is much to be commended, and the monograph will not only be of service to district officers and policemen, but will offer much information useful to the anthropologist.

(2) The north-west frontier of India and its people furnish the most difficult of the many problems which the Anglo-Indian statesman and soldier are compelled to solve. Since the annexation of the Punjab in 1849 these tribes have displayed the most fanatical resistance to our Government. Time after time punitive expeditions have penetrated every part of the wild country which lies between our territories and the kingdom of the Amir of Kabul. Conciliation has been tried without any success, and to-day our relations with these people are as unsatisfactory as they were more than sixty years ago. The only alleviation of this dangerous state of things is that the country has formed a splendid training ground for our troops, that it has developed the gallantry and resource of the British subaltern, and that many of the tribesmen have served with distinction in the armies of their hereditary enemies.

During the course of these expeditions and in other ways, surveys have been made of the borderland, and much information, geographical, statistical, and ethnological, has been collected. But up to the present the Indian Government, with its habitually excessive caution, has decided that these materials should be considered confidential, despite the fact that any foreign State interested in the military problems of India must already, by some underground means, have obtained the necessary information.

Photo] [*Mr. T. M. Salmond.*
Fig. [illegible].—View in the Mnaidra, showing pit-markings, dolmen, recess, table, and pillar. From "Malta and the Mediterranean Race."

The present book, for the first time, provides a *résumé* of some of this accumulated material. But the Indian War Office insisted that the MS. should be submitted to their scrutiny before publication. It begins with a short introduction from the pen of that fine soldier Sir H. Smith Dorrien, and passes on to a general description of the borderland, followed by a series of chapters dealing, each in succession, with a group of tribes, beginning with those of the Black Mountain and ending with the Wazirs. For each tribe or group of tribes we now have a concise account of their history, customs, and mode of life, a description of their country and the routes by which it can be penetrated, and of the successive expeditions directed against them. Colonel Wylly, who himself knows the ground, has done the work of condensing the material with much discretion and ability, and the book, though in the nature of a summary, is written in a graphic and readable style. It does not profess to give detailed references to the authorities on which it is based, and it is unfortunate that at least a bibliography of the most important literature available for study has not been supplied. A fine set of maps and a good index add to the value of the book. Though from its form it is unlikely to become popular with the general reader, it will be indispensable to the soldier on duty on the frontier and to the student of military history, while for the geographer and the ethnologist it, for the first time, draws aside the veil which has hitherto concealed a most interesting tract of country and tribes which, in spite of their cruelty and fanaticism, possess many admirable qualities. Now that light has been thrown upon them we may learn how to understand them better and establish more satisfactory relations with them.

(3) From its geographical position Malta was necessarily closely connected with that form of eastern Mediterranean culture which finds its most complete presentation in the discoveries made by Sir A. Evans in Crete and by Schliemann at Mycenae and other sites on the mainland of Greece. Hence a monograph summarising the results of the recent important excavations in Malta and a discussion of their relation to those in other parts of the Mediterranean and its border lands will be welcomed by archaeologists. Mr. Bradley has been personally engaged on the work of excavation with Dr. Ashby and the local antiquaries, and is thus in a position to undertake such a task.

In 1910 a prehistoric well tomb was discovered between Attard and Citta Vecchia, where, beneath an upper Punic stratum, human bones mixed with a deep red pigment were found associated with pottery of an early type. About the same time, Prof. Tagliaferro discovered a series of ossiferous caves at Bur Meghez, between Valetta and Hagiar Kim, in which numerous interments, also accompanied by primitive pottery, were unearthed. Perhaps most important of all is the discovery of the Hypogeum at Hal Safflieni, near the head of the Great Harbour. This important megalithic monument consists of two stories, the lower apparently used as a place of storage, being provided with bin-like structures, while above is a sanctuary which seems to have been concealed from public view by a curtain. Mr. Bradley gives a valuable account, accompanied by excellent photographs, of these interesting remains and of the pottery and other objects recovered from them. His theory that the dolmen originated in a cave burial and his survey of the prehistoric pottery deserve attention.

But he has not been content with describing these remains and tracing their analogues in the adjoining regions. The real object of his book, he tells us, is to portray the psychological characteristics of the pre-Aryan population of Europe with a view to explain how a race so highly gifted as the Cretan monuments show it to have been fell almost without a struggle before the Aryan invaders. This is a problem which is obviously only indirectly connected with the archaeology of Malta, though some side-lights useful for its solution may ultimately be derived from the discoveries in that island. But it raises a series of complicated questions, such as the Egyptian, Babylonian, or Phoenician influences in the eastern Mediterranean, the origin of megalithic monuments throughout the world, and so on, for the solution of which he can scarcely claim to possess the necessary qualifications. Such an inquiry is probably much too serious to be undertaken by any single scholar at the present time, and we must be content with a series of monographs dealing with the varied phases of this widespread culture before any comprehensive treatment of the subject as a whole comes to be possible.

NEW HYDROGEN SPECTRA.

IN 1896 Prof. E. C. Pickering discovered a series of lines in the spectrum of the star ζ Puppis which has been attributed to hydrogen in consequence of numerical relationship to the Balmer series ordinarily observed in laboratory experiments. From analogy with other spectra, Rydberg further calculated the positions of lines which would constitute the *Principal* series of hydrogen, and the first line, at 4687·88, has been identified with a line appearing in stars of the fifth type. The ζ Puppis lines have since been observed in the spectra of a few other stars, and because they had not been found in the terrestrial spectrum of hydrogen, even under the most promising conditions, they have commonly been considered to represent a modified form of hydrogen which could only be produced at very high temperatures. Hence, Sir Norman Lockyer gave the name "proto-hydrogen" to the gas which produces the lines in question, while others have called it "cosmic" hydrogen.

A further contribution to our knowledge of the spectrum of hydrogen was communicated to the Royal Astronomical Society on December 13 by Mr. A. Fowler, who has succeeded in producing four lines of the Principal series, three of the ζ Puppis series, and three lines of an ultra-violet series which has not previously been suspected. The new lines were obtained by passing a strong condensed discharge through an ordinary Plücker tube containing a mixture of hydrogen and helium, and it is remarkable that it was not found possible to produce them from hydrogen alone, under apparently identical conditions. At low pressures the lines appeared in the bulbs, close to the junctions with the capillary tube, and were then sharply defined. At higher pressures the lines of the Principal and new series were very bright and broad in the capillary tube, but the ζ Puppis lines were not observed.

The positions of the observed lines of the Principal series are 4685·98, 2733·34, 2385·47, and 2252·88, all of which are slightly more refrangible than the wave-lengths calculated by Rydberg. Using oscillation frequencies *in vacuo*, the lines are represented by the equation

$$n = 48764{\cdot}0 - \frac{109675}{(m + 0{\cdot}999606)^2}$$

where m has the values 1, 2, 3, 4. The wave-length of the first line sufficiently justifies its identification with the high-level line 4685·90 in the chromosphere (Lockyer), the nebular line 4685·73 (Wright), the Orion star line 4685·4 (Pickering), and probably also with 4688 of the bright line stars.

The new ultra-violet series includes strong lines at 3203·30, 2511·31, and 2306·20, which may be connected by the equation

$$n = 48763{\cdot}8 - \frac{109675}{(m + 0{\cdot}499506)^2},$$

where m has the values 2, 3, 4. The limit is identical with that of the Principal series, and the new lines are provisionally regarded as forming a second Principal series. Hydrogen is apparently unique in having two Principal series so related. It has so far only been possible to identify three members of the ζ Puppis series, their approximate wave-lengths being 5410·5, 4541·3, and 4200·3.

The investigation is regarded as giving another indication of the probability that there are no special kinds of matter in celestial bodies, and that most of the celestial spectra are reproducible in laboratory experiments.

PELLAGRA.

THE announcement, a few weeks ago, that pellagra has been found in the British Islands is of no slight importance. For, if half-a-dozen genuine cases have been found, we may be fairly sure that many hundreds are waiting to be found. In the United States, it is only five years since Dr. Babcock and Dr. Watson directed general attention to the presence of this disease in their country. We now have clear evidence that pellagra has been found in no fewer than thirty-five States; and several thousands of cases have already been found and noted. In the final stage, the central nervous system is affected, and the patient is apt to become insane; it is possible, therefore, that many cases will be found, by diligent examination, among the inmates of asylums. Still, we have no reason to believe that pellagra has ever been, or will ever be, so heavy on this country as on Italy.

Out of the admirable work done by the Pellagra Commission (1909) came Dr. Sambon's theory that the disease is one of the insect-borne infections, and that the infecting agent is Simulium, one of the "midges." It is a not improbable corollary, with some direct evidence in its favour, that the organism of pellagra is a protozoon, similar in nature to the protozoon of malaria.

Against this theory, based on long and laborious study of the districts where pellagra lies heaviest on the people, there is the old theory that the disease is due to the eating of unwholesome maize: that some bacterial change in the maize causes it to act as a slow poison. Perhaps, in a few years, these opposed theories, which now seem utterly irreconcilable, may be brought nearer together by a new series of observations, at some level which is not yet in sight. Meanwhile, in the general opinion of experts, the old theory—that bad maize, *ipso facto*, induces pellagra—is losing ground. One is reminded of the old theory that the eating of the manioc-root was the cause of the African sleeping-sickness; and one is tempted to think that the maize-theory of pellagra will have the same fate.

Certainly, if a notable number of cases of the disease be found in this country, the maize-theory will become even harder to hold.

The earliest full account, in our language, of the disease is probably the paper by Dr. Sandwith (Brit. Med. Ass. Edinburgh meeting, 1898). His study of pellagra in Lower Egypt is well known to all pathologists. For the facts about pellagra in the United States we have Dr. Niles's recent book, "Pellagra: an American Problem" (Saunders, Philadelphia, 1912), and, with much other literature, two important papers in the Transactions of the Society of Tropical Medicine and Hygiene (January, 1912), by Dr. Stannus and Dr. Sandwith, with a discussion, in which Dr. Sambon and Dr. Chalmers took part. The reference to pellagra in the British Islands is *British Medical Journal*, October 26, 1912.

It is fairly certain that careful collective investigation will bring to light many cases of pellagra in this country, and the experts will perhaps be enabled thereby to set aside the "maize theory," and all modified forms of that theory, and to class the disease with malaria, yellow fever, and sleeping sickness. Still, it is not impossible that the maize theory and the Simulium theory may, by further study of the facts of the incidence and geographical distribution of the disease, be found less hostile to each other than they appear to be at the present time.

NOTES.

WE heartily welcome the new Society for the Promotion of Nature Reserves. Its objects, as officially stated, are as follows:—(1) To collect and collate information as to areas of land in the United Kingdom which retain their primitive conditions and contain rare and local species liable to extinction owing to building, drainage, and disafforestation, or in consequence of the cupidity of collectors. All such information to be treated as strictly confidential. (2) To prepare a scheme showing which areas should be secured. (3) To obtain these areas and hand them over to the National Trust under such conditions as may be necessary. (4) To preserve for posterity as a national possession some part at least of our native land, its fauna, flora, and geological features. (5) To encourage the love of nature and to educate public opinion to a better knowledge of the value of nature-study. The president is the Right Hon. J. W. Lowther, M.P., the hon. secretaries are Mr. W. R. Ogilvie-Grant and the Hon. F. R. Henley. The temporary address of the society is the Natural History Museum, Cromwell Road, S.W. There is no subscription. The principle of centralising the various efforts already instituted in this country towards the preservation of its "natural monuments" has for some time past been advocated in these columns. The mechanism by which reservation is to be effected has already been put into operation by the acquisition of Blakeney Point in Norfolk. The highly successful scheme which has been worked in Prussia for some eight years is, we may note, governmental, and has a special commissioner, Dr. Conwentz, the pioneer of the movement, at its head. It seems to us that some such close connection with the national executive is essential for the full success of any society, however strong.

At the Dundee meeting of the British Association in September last the president of the Zoological Section, Dr. P. Chalmers Mitchell, F.R.S., took as the subject of his address, "The Preservation of Fauna." At the close of the meeting the general committee passed on to the council, for consideration, a resolution, which has now been adopted in the following terms:—"That the British Association for the Advancement of Science deplores the rapid destruction of fauna and flora throughout the world, and regards it as an urgent duty that steps should be taken, by the formation of suitably placed reserves, or otherwise, to secure the preservation of examples of all species of animals and plants, irrespective of their economic or sporting value, except in cases where it has been clearly proved that the preservation of particular organisms, even in restricted numbers and places, is a menace to human welfare."

The news of the death of Mr. Henry de Mosenthal, which occurred on December 18, at sixty-two years of age, will be deeply regretted by those numerous friends and technologists with whom his long association with the well-known firm of Nobels brought him into relationship. Mr. de Mosenthal had acted as technical secretary since the formation of the Dynamite Trust Company in 1886, but his association with Nobels goes back some years earlier. Mr. de Mosenthal became a member of the Society of Chemical Industry in 1888, and two years later he was elected a fellow of the Chemical Society. He contributed to the publications of each, and the series of three papers on observations on cotton and nitrated cotton appearing in the Journal of the former society in 1904, 1907, and 1911 record a large number of valuable determinations of the physical properties of these bodies, especially in solution. In the first contribution he demonstrated that the cuticle of the cotton fibre is extremely porous, that rows of pores and stomata may be observed on the surface under oblique illumination. His experiments also showed that the single cotton fibre exhibited no capillary action, which is contrary to the commonly accepted view, but that several fibres must be in contact before the well-known capillary action became manifest.

The Paris Société d'Encouragement has received a legacy of 4000*l.*, bequeathed to it by the late M. Osmond.

The silver medal of the Zoological Society has been conferred on Major J. Stevenson-Hamilton, Game Warden of the Transvaal, in recognition of his valuable services in connection with the King's African collection.

We learn from *The Times* that a new cancer institute has been established at the Brompton Cancer Hospital, at a cost of some 6000*l.* The importance of X-rays and other electrical methods in the treatment of malignant disease is now fully recognised, and the institute has in its possession an excellent equipment for this branch of therapeutics.

The director of the Science Museum, South Kensington, informs us that a temporary collection at the museum in illustration of the history of aëronautics and some of the scientific researches which are applied in the design, construction, and use of aëroplanes will be open to the public from December 23 until the end of January.

The eighty-first annual meeting of the British Medical Association will be held in Brighton next July. The president's address will be delivered on July 22, and the sections will meet on the three following days. Dr. W. A. Hollis, consulting physician, Sussex County Hospital, is the president-elect. The address in medicine will be delivered by Prof. G. R. Murray, physician to the Royal Infirmary, Manchester, on July 23. The address in surgery will be delivered by Sir Berkeley Moynihan, professor of clinical surgery in the University of Leeds, on July 24. The popular lecture will be delivered by Mr. E. J. Spitta on the evening of July 25. The scientific business of the meeting will be conducted in fifteen sections, which will meet on July 23 to 25. These sections, with their presidents, are as follows:—Bacteriology and Pathology, Dr. J. W. H. Eyre; Dermatology, Dr. J. H. Sequeira; Diseases of Children, including orthopædus, Dr. G. F. Still; Electro-therapeutics, Mr. W. D. Butcher; Gynæcology and Obstetrics, Mr. R. Sanderson; Laryngology, Rhinology, and Otology, Mr. A. J. Hutchison; Medical Sociology, Dr. R. J. Ryle; Medicine, Dr. E. Hobhouse; Navy and Army, and Ambulance, Colonel James Turton, V.D.; Neurology and Psychological Medicine, Dr. J. Taylor; Ophthalmology, Mr. T. H. Bickerton; Pharmacology, Therapeutics, and Dietetics, Dr. W. H. Hale; State Medicine, Dr. E. W. Hope; Surgery, Mr. W. T. Thomas; Tropical Medicine, Lieut.-Colonel Sir William Leishman, F.R.S.

The report of the council of the Scottish Meteorological Society, adopted at the annual general meeting on December 10, shows that during the past twelve months the society's system of observations has been strengthened by the re-establishment on a satisfactory basis of a station at Braemar, with Mr. A. M. Shirran as principal observer. Observations were originally established there under the direction of the late Prince Consort; a continuous series exists for the period 1856–1905. The Registrar-General for Scotland has been supplied regularly with monthly and quarterly reports from the office of the society, and also, direct from the observers in eight of the large towns of Scotland, with the daily observations of temperature and rainfall required for his weekly reports. The Meteorological Office in London has received direct from the observers at certain stations daily observations of temperature, rainfall, and, in some cases, sunshine for its Weekly Weather Reports. The council regrets to report a shrinkage in the membership of the society, due largely to the deaths of subscribers of long standing. A shrinkage in membership implies a reduction of income, and but for a considerable demand for the society's publications, there would have been a serious deficit for the financial year ending June 30 last. The expenditure of the society has been reduced to the lowest possible limit, but it will exceed the income for the current year unless there is a large accession of new members. The council has lodged an application with the Registrar-General for Scotland for a grant sufficient to defray the entire cost of the reports supplied to him by the society. Mr. J. Mackay Bernard has been elected president for the coming year.

Prof. H. H. W. Pearson, of the South African College, Cape Town, sends us a copy of a letter from *The Cape Times* of October 29 last, wherein the Hon. A. Wilmot, formerly a member of the Cape Legislative Council, describes the appearance from the deck of ss. *Dover Castle*, then in the southern portion of the Gulf of Guinea, of an object regarded as "the head and neck of a monster—seemingly a serpent—extending at least fourteen feet above sea-level. Mr. Wilmot saw this object, as it pursued its way through the water, six times in the space of about two minutes; and it was independently noticed once or twice by several persons on board. The day, October 17, was exceedingly clear, and, according to Mr. Wilmot, "it is preposterous to talk of five independent witnesses being imposed upon by mistaking porpoises, a flight of sea-birds, seaweed, or cane for the sea monster they undoubtedly did see at a distance estimated at one and a half miles." In the face of this testimony no one will deny that something strange to the passengers, but interpreted as the head and neck of a serpent, was observed by them on the occasion mentioned. But since there is neither sketch nor detailed description of the apparition to help in determining to what class of the animal kingdom it belonged, we venture to suggest that it may have been the upraised tentacular arm of a large kind of pelagic squid swimming near the surface. These arms are long and flexible, and expand somewhat abruptly at the end into an enlargement which at a distance might be mistaken for the head of a snake attached to a slender neck. The size of the object observed is no obstacle to this suggested explanation, since the tentacular arms of some of these gigantic squids reach a length of about thirty feet.

Among the Bulletins of the Philosophical Society of the University of Virginia there appeared in July, 1912, a paper by Mr. H. E. Jordan, entitled "Studies in Human Heredity." The characters dealt with are left-handedness, pulmonary tuberculosis, cancer, hermaphroditism, onyxis (ingrowing toe-nails), nephritis, and melancholia. The method of study is the collection of pedigrees, on which a Mendelian interpretation is put with rather too great readiness. It is to be regretted that some care was not taken to describe the actual condition found in each individual. This lack of definite information is particularly noticeable in the case of left-handedness, which occupies more than half the paper. Left-handedness occurs in a variety of forms, and it would have added much to the value of the pedigrees if the author had noted, wherever possible, in what manner it was exhibited. Among the left-handed acquaintances of the present writer one used to write left-handed, but played games right-handed; in the majority this condition is reversed. One was in his early childhood so apt with left hand that he learnt to write with it, and then, having acquired the art of writing clearly and well, he appeared to forget it again; his letters became more and more unformed and slovenly in appearance, until, at the age of six and a half, it was thought better that he should commence again with his right hand. Would Mr. Jordan class all these cases indiscriminately as left-handed?

To *The Field* of December 14 Mr. Pocock contributes a note, with an illustration, of two long-beaked spiny anteaters now on exhibition in the Zoological Society's Gardens. They form, apparently, part of a consignment of eight recently brought by Mr. Paul Kibler from the Charles Louis Mountains of Dutch New Guinea. In commenting on the height at which the body is carried above the ground—a feature in which these anteaters differ from the ordinary species—Mr. Pocock states that the pose of the limbs should be compared with that of tortoises rather than with that of elephants. The author quotes a letter from the Hon. Walter Rothschild relative to the five races by which the long-beaked species is locally represented in New Guinea.

In the November issue of the Journal of the East Africa and Uganda Natural History Society reference is made to a decrease in the membership of the society and the lack of sufficient literary matter for the journal, of which only two numbers are in the future to be issued annually. Such want of support is to be deplored, especially in a country so rich in natural history subjects as Uganda. In an article on early man Mr. C. W. Hobley observes that while stone implements are common in Egypt and Cape Colony, they are relatively rare in B.E. Africa; and suggests that this may be due to the sparse population of the country in prehistoric times, when volcanic action appears to have been rife. Most of the implements hitherto found are of a crude type; and if it be true, as some suppose, that Africa was the cradle of the art of working in iron, this industry may have crushed out of existence the manufacture of stone implements, which consequently never attained the beauty and finish characterising those of Neolithic Europe.

THE zoological expedition to the Altai Mountains, Siberia, and Mongolia, organised and carried out by the cooperation of the United States National Museum with the Museum of Comparative Zoology at Harvard, has recently returned to the United States after an especially successful trip of about four months' duration. The expedition was under the direction of Dr. Theodore Lyman, of Cambridge, Mass., and the National Museum was represented by Mr. N. Hollister, of the division of mammals. It was the object of the expedition to collect the mammals and birds of the Altai Mountains, especially the very large wild sheep of this region, and in this respect the expedition succeeded far beyond expectations. Among the small mammals there have been found several new species, diagnoses of which are given in a pamphlet entitled, "New Mammals from the Highlands of Siberia," written by Mr. Hollister, and just published by the Smithsonian Institution, forming publication No. 2157 of the Smithsonian Miscellaneous Collections. The whole collection includes about 750 mammals and birds, among them a fine series of the wild sheep of the Altai region, which is the largest known species of sheep, together with ibexes, gazelles, and other large game. The specimens will be divided between the two institutions interested.

THE U.S. Department of Agriculture has issued (Forestry Service, Bulletin 85) a description of the chaparral, or dwarf forest vegetation of Southern California, by F. G. Plummer. The chaparral, or "elfin wood," is one of the types of stunted forest—a plant formation found in several widely separated parts of the world and is one of the intermediate forms between a flourishing forest and a desert, representing a condition of balance between certain environmental extremes, a balance at which the growth is dwarfed and the full-grown trees attain only the dimensions of brush, being rarely more than 10 ft. high. It is sharply distinguished in composition from the dwarf forest formations of high latitudes and altitudes on one hand, and from the tropical and subtropical dwarf forests on the other; its dominant species belong to the genera Adenostoma, Arctostaphylos, Ceanothus, and Quercus, though the dominant forms often vary on adjacent watersheds. The memoir includes a discussion of the ecological relations of the chaparral species, the importance of the tree-cover in conserving moisture, the methods of controlling the destructive fires which rapidly sweep the more or less arid vegetation, and the possibility of introducing large tree species; hence it is of interest to the forester and geographer, as well as to the botanist.

ANOTHER text-book, modestly styled a "Guide to the Collection of Gemstones in the Museum of Practical Geology," has been issued by that museum (obtainable through any bookseller from T. Fisher Unwin, London, price 9d.). Mr. W. F. P. McLintock here describes the properties of gems, with an excellent account of the influence of refractive index and internal reflection, and of the mysterious nature of colour. Eight pages are devoted to artificial gems. In the descriptive portion, euclase, benitoite, and variscite take their place as gemstones.

OBERLEHRER L. WUNDER, of Sendelbach bei Lohr, has published separately, through Teubner of Leipzig (price 1.50 marks), his observations on the Kerlingarfjöll and other highlands in Iceland. He has determined barometrically, with due precautions, a number of heights for the first time, and is able to correct some features of the current geological map of the country. His observations on the rapid variations of glacier-streams as the comparatively feeble sunlight waxes or wanes are of considerable interest. In the Hofsjökull a true ice-dome of the Norwegian type is encountered, with marginal glacier-tongues.

THE continued interest taken by geologists in the origin of the British Triassic strata has been more than once noticed in these columns. Mr. T. O. Bosworth has now published, though the Leicester Literary and Philosophical Society, his researches on "The Keuper Marls around Charnwood" (Leicester: Thornley and Son). Particular attention is paid in this excellently illustrated volume to the rock-surfaces exposed by quarrying beneath the Trias, and to the blocks from these surfaces carried into the marls by weathering agents in Triassic times. More than 40 per cent. of calcium and magnesium carbonate has been found in some of the marls. The author believes that the red marls accumulated in comparatively deep standing pools, the alternating grey bands representing coarser matter swept in from the desert areas during rains.

PROF. S. PASSARGE has written, as a part in the *Mitteilungen* of the Geographical Society of Hamburg (Hamburg, L. Friederichsen and Co., 1912), an elaborate survey of morphological geography, which he endeavours to classify with the same precision as a department in zoology. His method can be indicated by quoting an example. In systematic morphology the two "types" are land-forms and coast-forms. In the first of these, volcanic-forms make the second order in the class of endogenous forms, and this order is divided into the family of intrusions and eruption-forms, the latter being separated into one genus (*Gattung*) of explosive discharges and another of effusive discharges, the second consisting of the following specific forms: dome-volcanoes, shield-volcanoes, and flows. This has a very orderly aspect, and examples may be found which can be easily fitted into the several pigeon-holes, but most volcanoes of any size are composite in character, built up of discharges of scoria and flows of lava, and traversed by dykes and other intrusions. To draw hard and fast lines is more difficult in geography than most other branches of science, and, although some technical terms are necessary, it is doubtful whether they can be very precisely defined. Prof. Passarge's work is an example of German thoroughness, with perhaps a corresponding tendency to over-classification, and it will be found, we think, more useful to teachers than to students, for the latter may find that minute attention to the trees rather hinders them from seeing the wood.

DR. PHILIP EREDIA sends us a useful discussion, entitled "The Diurnal Variation of Temperature in Italy" (excerpt from the Annals of the Central

Meteorological Office, part i., 1912). The investigation is based on observations from 1892–1906 at 120 stations, at which no interruption had taken place during the period. The tables include monthly, seasonal, and yearly mean values of the daily maxima and minima, and of their difference (or mean daily range), each being separately treated, except in the annual summary. This special treatment of the various data, especially of the daily range, is of considerable climatic interest. The author also gives, for all stations, the value for each month and season of the varying coefficient involved in Kämtz's formula for obtaining true daily means of temperature. Among many useful results it is noted that, generally speaking, the effect of latitude is not very distinctly shown in the annual values of the maxima and minima, owing to the many local influences at work. The annual range is greatest in the interior, especially in Upper Italy, where, proceeding inland from the Adriatic coast, constantly increasing values occur.

THE International Geodetic Conference, which met at Hamburg in September last, among other important questions discussed the subject of the precision of a level network, and laid down a new standard of accuracy for "nivellements de haute précision." Such a standard will doubtless prove of great value to the directors of large surveys plannning new levelling work, and it will be interesting to see a detailed discussion of the errors of an actual reseau compared with the limiting errors calculated from the formulæ approved by the conference. Short of this, it is not possible to institute a strict comparison between the two, but it would appear that good modern work, such, for instance, as the Indian Survey Department's precision levelling, falls well within the prescribed limit. The thanks of all geodesists are due to Lieut.-Col. Lallemand for the trouble he has taken in this matter, and for his long-continued and most valuable contributions to this branch of geodesy. Pending the publication of the conference volume, a summary of the formulæ in question will be found in the *Comptes rendus* of the Paris Academy of Sciences for October 14, 1912.

THE indefatigable and distinguished seismologist, Dr. F. Omori, in vol. v., No. 7, of the Japan *Astronomical Herald*, has branched off on a new line and given us an interesting and instructive article on the variation of latitude and changes in the mean sea-level of Japan. First we are introduced to a table which gives in millimetres mean sea-level in successive years at nine stations round the coast of Japan. A glance at this shows that although sea-level during twelve months may have increased at one station, at other stations during the same period it may have decreased. The greatest fluctuations appear to have taken place at Misaki, which lies just outside the Bay of Yedo. In 1897 the sea-level at this place remained constant, but by 1909 it had risen 166 millimetres. An annual average value of the records of nine stations, when they are plotted on squared paper, show that sea-level was low in 1897 and 1902, but it was high in 1899 and 1905. Beneath this diagram Dr. Omori has given a curve showing changes in latitude as observed at Tokyo and Mizusawa. The resemblance between these two diagrams is very striking, and from them it appears that a variation of $0''\cdot 1$ in latitude is accompanied by a change of 42 millimetres in sea-level.

A PAPER on searchlights for the mercantile marine, read before the Manchester Literary and Philosophical Society by Dr. Henry Wilde, F.R.S., on May 7, was reported and commented upon in the issue of NATURE for May 30 (vol. lxxxix., p. 325). On November 12 Dr. Wilde returned to the question in a paper, entitled "On Searchlights and the *Titanic* Disaster," which he read to the same society. In this paper he passes in review the evidence given in connection with the use of searchlights in the report on the loss of the *Titanic*, and also the statements in the report of the Merchant Shipping Advisory Committee of the Board of Trade. After considering these reports, Dr. Wilde concludes his paper thus:—"In view of the facts brought out by the several committees engaged in investigating the causes leading to the loss of the *Titanic*, it only remains for me to repeat and to emphasise the statement made in my paper read before the society in May last, that the ultimate responsibility of a calamity which the world deplores rests upon the British naval authorities through their fatuous policy of excluding searchlights from the Mercantile Marine."

IN the *Journal de Physique* for November, M. J. Bosler, in a paper on the relations between magnetic storms, earth currents, and solar eruptions, puts forward a theory of the production of magnetic storms which he believes to be new. He was, it appears, led to it by finding that the horizontal component of the disturbing force in a magnetic storm is on the average at right angles to the direction of the earth current observed at the same instant at the same station, and that these currents flow at each station in a direction which is nearly constant. At Parc Saint Maur, near Paris, for example, the direction is in general from north-east to south-west. M. Bosler considers these currents the cause of magnetic storms, and explains them as due to the expression for the magnetic induction through the earth having in it a variable term owing to electrified matter projected from the sun. This variable term would result in an electric current about the earth which in turn would produce a magnetic disturbance. Unfortunately, the author does not indicate how the term expressing the variable induction arises, nor does he trace the consequences of his theory any further. It seems, for example, to demand that magnetic storms should be most intense at any instant in the great circle perpendicular to the variable magnetic induction, a conclusion which might have been tested by comparison with observations.

PROF. C. RAVENNA and Mr. G. Bosinelli describe in the *Atti R. Accad. Lincei* (vol. xxi., ii., 355) further experiments to ascertain whether the traces of hydrogen cyanide found in young plants exist therein in the free state, or solely in the form of cyanogenetic glucoside from which they are liberated by the action of an enzyme under the conditions of making the test.

The experiments were carried out with cherry laurel, *Phaseolus lunatus*, and germinating almond, and instead of using boiling dilute alkali to kill the plants, as in former experiments, concentrated salt solutions boiling at 110° were employed; in this way the plant enzymes were more rapidly destroyed, with the result that the amount of hydrogen cyanide indicated was thereby considerably diminished. It is thus considered probable that free hydrogen cyanide does not occur as such in the plant.

REPORT OF THE DEVELOPMENT COMMISSIONERS.

THE second report of the Development Commissioners, for the year ended March 31, 1912 (Wyman and Sons, price 8*d*.), was issued recently. It will prove convenient to review the report briefly under the chief headings contained therein.

General Position of Commissioners and Principles of Action.—As previously announced, the Commissioners cannot themselves make grants or loans, do not possess executive powers, and must receive applications through Government departments before reporting to the Treasury. It is gratifying to learn that the recommendations of the Commissioners have been adopted in all cases of importance. Owing to the fact that money must be entrusted to some suitable body, difficulties have arisen with regard to canals, roads, and some other matters coming within the scope of the fund, but it is expected that such difficulties will ultimately be overcome. The system of block grants has been adopted, which, though entailing some delay, is held to secure greater efficiency.

Although existing expenditure is not to be relieved, and local contributions are required, it is felt that authorities which have spent freely in the past should not be expected to find so large a proportion of the total sum to be expended in their areas as authorities which have been less enterprising.

The principle of loans is adopted for schemes expected to give a direct return ultimately. In some cases, such as afforestation, advances will be made on condition that the extent of the operations be varied according to the state of the labour market, so that some relief of unemployment may result. This does not apply to such part of the 325,000*l*. allotted to farm institutes as may be required for erecting buildings, these being urgently necessary.

The principle that the fund must not be used to benefit private individuals directly creates difficulties in the case of canals, estate afforestation, and light railways; for grants are here debarred, although private profits are associated with public benefits of an important kind. A different view must be taken of applications from public authorities for money to be applied in loans or grants to individuals, *e.g.* to fishermen. Such loans or grants would appear to be legitimate if they place individuals in a better position to help themselves, as in the case of advances enabling fishermen to acquire motor-boats.

The Commissioners consider it their duty to recommend expenditure when and where most likely to be remunerative with reference to the economic development of the United Kingdom as a whole, even though this may appear unfair to certain localities. The provision of harbours for steam-drifters, for example, is regarded as more important than the development of small centres employing more antiquated methods of catching fish.

I. *Agriculture and Rural Industries.*—Three chief lines of action are reaffirmed as those of greatest importance, *i.e.* scientific investigation, research, and education as means of improving the quality and increasing the amount of agricultural products; supply of information regarding new crops and industries to cultivators for enabling extended practice; improvement of commercial methods by promotion of cooperation.

It is considered that pure research is not a local matter, and that it must be continuous and concentrated. Hence the selection of a comparatively small number of centres for research in the eleven main branches of agricultural science. It is recognised that research and education should be in close touch with one another, and although the fund is to be devoted to economic development, the Commissioners feel that when subsidising research the canon of apparent economic value should be cautiously applied.

In addition to grants to institutions, a sum of 3000*l*. per annum (probably to be increased to 5000*l*.) is reserved for individual investigators much on the lines adopted for the 4000*l*. per annum entrusted to the Royal Society for distribution. In this way it will be possible to utilise individual research ability wherever found. For purposes other than research England and Wales are to be divided into twelve provinces, each with its agricultural college providing the highest kind of agricultural education, demonstrating the results of research, and giving advice to farmers. The lower grades of instruction and advice will be provided by the farm institutes. The Commissioners consider that such an institute should possess two essential characteristics: first, the provision of shorter, simpler, and cheaper courses than those given at colleges; secondly, that it should serve as the headquarters of the county staff. A very large amount of elasticity is regarded as desirable, and there need be no "material embodiment in bricks and mortar." The general lines approved closely resemble those advocated at the cooperative conferences held between the governors of the Royal Agricultural College, Cirencester, and representatives of several county authorities in 1911.

Flax, hemp, tobacco, and beet are cited as crops requiring full investigation in order to determine whether they can be made a commercial success in this country.

The existing voluntary societies are to be utilised in organising cooperation, largely because "cooperation is particularly the kind of movement to which it is essential to retain the enthusiasm of voluntary workers." Considering the enormous amount of dairy and other farm produce imported, it is distressing to learn that "the question of agricultural cooperation in Ireland is unfortunately complicated by political differences." Other directions of activity include the continuance of light horse breeding schemes, the establishment of a cattle-testing station, and of a national poultry institute.

II. *Forestry.*—One guiding principle is here adopted, *i.e.* that "education and the provision of technical advice are the best lines of advance for the immediate present." This general idea is given effect by the recognition of five centres in England and Wales (Oxford, Cambridge, Cirencester, Bangor, and Newcastle), with suitable provision for Scotland and Ireland. Why the Commissioners consider that Oxford and Cambridge should be equipped for "higher education in forestry," and the other three centres for "forestry education of a simpler kind," is a mystery, without some reason for believing that the education so far given at Oxford and Cambridge has been superior to that obtainable elsewhere. The two older universities are also to be the chief centres for research.

The Commissioners further approve of loans to local authorities for afforestation of suitable land, *e.g.* water catchment areas.

Some advance has been made in matters comprised under the remaining headings of the report, namely:—

III. *Land Drainage and Reclamation.*—One Irish scheme (Owenmore) approved.

IV. *Rural Transport.*—Considering the vital importance to small holders and others of this matter it is astonishing to find that only a very few applications, all Irish, have been received. No grants were recommended.

V. *Harbours.*—The Commissioners make a number of important recommendations, on the lines indicated in an earlier part of this review.

VI. *Inland Navigations.*—Technical difficulties retard this direction of advance, but loans are recommended for improvement of the Stort and Upper Medway.

VII. *Fisheries.*—Substantial grants to various authorities are recommended, partly for scientific research, and partly for improvement of harbours, and other purposes. Concessions to Irish fishermen by way of loans are also recommended.

VIII. *Miscellaneous.*—An application by the Meteorological Office was not entertained.

IX. *Compulsory Orders for the Acquisition of Land.*—Only one small and unimportant order has been made.

Within the limits of our space it is impossible to deal with the last part of the report, which is devoted to finance, but it is stated that in all cases the Commissioners "have tried to follow sound principles of finance and administration, to take a broad view of the questions involved, and to avoid any haphazard and spasmodic distribution of public money."

The Commissioners may be congratulated on having made very considerable progress during the year, and the principles of their action appear to be fairly sound, though they are somewhat handicapped by the unusually small proportion of scientific experts to be found among them. It is, however, very gratifying to know that the whole time of Mr. A. D. Hall is in future to be given to development work. Now and then we find that a sound principle advocated is not worked out satisfactorily in practice by the responsible authority. For example, on p. 11 of the report we read that the grants available from various resources "will provide for utilising to the full the energies of the Agricultural Colleges in teaching, in research, and in giving technical advice to farmers on practical difficulties involving problems which are beyond the scope of either an experienced agriculturist or even a member of the County Staff." Yet a grant of 1000*l.* per annum for advisory work in horticulture and agriculture has been made to the University of Bristol, none of which has been allocated to the associated Royal Agricultural College at Cirencester, the pioneer institution, accustomed to give the kind of advice contemplated for nearly seventy years. The progress made as regards cooperation and rural transport is disappointingly slow, considering the great importance of these for enabling farmers to cope with foreign competition, but the Commissioners can scarcely be blamed for the delay. Ultimately, we may hope to see a substantial reduction in the enormous sums paid to foreign countries for agricultural products.

RECENT PUBLICATIONS ON THE FERTILITY OF THE SOIL.

RECENT inquiries have shown that the fertility of agricultural land in Europe has very materially increased owing to the use of commercial fertilisers and green manuring, but it has often been stated that this increase is effected at the expense of virgin lands. Mr. Coventry therefore instituted an inquiry in India to see if there is any evidence of a progressive decline in fertility there. The results are published in vol. vii. of *The Agricultural Journal of India*, and show that the average of productivity may have become lower, but this can be entirely explained by the fact that inferior lands have been taken into cultivation on account of the great agricultural prosperity and expansion brought about under British rule. When allowance is made for this it is seen that the fertility is not declining, but rather tends to increase.

It is, however, undeniable that phosphoric acid and potash are removed from the soil in the crop and transferred to the centres of population. Impoverishment of the virgin soils necessarily takes place, although the productiveness is not affected until lack of these particular nutrients becomes the limiting factor in crop production. This position has been reached in parts of the United States, and has induced Prof. Whitson and his colleagues at the Wisconsin Experiment Station to undertake a valuable set of investigations on the effect on the soil of rock phosphate, which fortunately is readily obtainable. In the admirable surveys of Wisconsin now being made by Dr. Weidman it is shown that continued cropping has caused phosphate exhaustion, which can be remedied by dressings of rock phosphate.

The other side of the question, the increased phosphorus supply to land near cities, is very well seen in many parts of England, and has recently been strikingly illustrated by Messrs. Hughes and Aladjem in a paper in *The Agricultural Journal of Egypt* (vol. i., part ii.). Analysis of soils taken from various places in the Delta showed that certain spots were much richer in phosphates than usual, although in other respects the soils were fairly uniform. Detailed examination of one of these cases showed that the authors were working on the site of an ancient city where a considerable population had existed for a period of at least four thousand years before the Arab domination. To supply such a population and the animals belonging to it with food must have required the produce of a large area, while the refuse of the city would be used as manure only on the nearer land. The city and its population have long since vanished, but the concentration of phosphoric acid in the soil remains an indelible record of the past:—

Distance from the centre of Kom, kilometres ...	0–1	1–2	2–3	3–4	4 5
Total phosphoric acid, per cent.	0·34	0·29	0·26	0·22	0·22
Easily soluble phosphoric acid, per cent.	0·086	0·069	0·065	0·051	0·036

Nitrogen compounds are also transferred, like phosphorus compounds, but they take part in a perpetual cycle in which the nitrogen of the air plays a part, so that the accumulation and depletion processes are both limited. Much work is being done on this cycle; in particular, investigators in all countries are finding that addition to the soil of easily oxidisable organic substances, such as sugar, conditions a notable fixation of atmospheric nitrogen. Indeed, in tropical countries where sugar-cane is cultivated, molasses are sometimes actually added to the soil for this purpose. The action of the sugar is not entirely simple, however, and Peck has shown that in Hawaii it may actually do harm by bringing about a marked decomposition of the nitrates (Bull. No. 39, Hawaiian Sugar Planters' Association).

It is, however, now realised that soil fertility is not wholly a matter of plant food, but may be limited by the presence of harmful substances in the soil. This phase of the problem is being investigated by Schreiner and Skinner, who have recently published (Bull. No. 77, Bureau of Soils, U.S. Dept. of Agriculture) a detailed account of the action of coumarin, vanillin, and quinone on plant growth. The general research of which this forms part consists in isolating from the soil such organic compounds as can be identified, and then trying their effect on plant growth.

It would be a mistake to suppose that the medium on which the soil organisms live and which is in contact with the plant roots is the inert mineral matter that constitutes the bulk of the soil. Recent investigations have brought into prominence the colloidal constituents that occur in notable quantity and appear to be distributed over the surfaces of the particles, and apparently impart to the soil many of its characteristic properties. On general grounds, it might be expected that these colloids would be much altered by the addition of small quantities of soluble salts, and the experiments of R. O. E. Davis (Bull. No. 82, Bureau of Soils) have justified this view, and have shown in what way the changes affect the physical properties.

The re-establishment of vegetation on devastated areas presents many important problems, and much interest attaches to a paper by W. N. Sands on the return of vegetation and the revival of agriculture in the area devastated by the Soufrière eruption in St. Vincent, 1902–3. The paper is published in the West Indian Bulletin, vol. xii., No. 1, and is well illustrated. Vegetation now flourishes wherever the old soil remains, even when a considerable admixture of ash has taken place. The ash itself, however, is unsuited to vegetation, and where no soil is present vegetation is very scanty. Once, however, plants begin to get a footing improvement speedily takes place, as the substances formed on their decay furnish supplies of plant food. In dealing with the agriculture, it is noted that yields are now in some cases higher than formerly; this result is attributed to the heating of the soil by the lava, and is discussed in the light of recent work at Rothamsted.

E. J. R.

UPPER AIR INVESTIGATIONS.

With the beginning of this year the Meteorological Service of Belgium completed its hundredth international balloon ascent, and the director, M. Vincent, considered this to be a suitable occasion for communicating to the Royal Academy (*Bulletin de la Classe des Sciences*, 1912, No. 6) some of the data deduced therefrom. The complete results are included with those obtained in other countries in a special publication compiled by the president of the International Commission for Scientific Aëronautics and elsewhere.

The recording apparatus used is the Bosch-Hergesell baro-thermo-hygrograph, and this is suspended to the smaller of two rubber balloons, coupled in tandem and inflated with hydrogen gas. The larger balloon bursts at a variable height, and the rapidity of the fall of the apparatus is slackened by the smaller balloon. This remains floating as soon as the apparatus reaches the ground, and serves as a signal to its whereabouts. After making allowance for accidents, ninety-two of the records obtained remained available for examination. The highest altitude reached was 32,430 metres (determined from the pressure and temperature curves by means of Laplace's formula) on June 9, 1911. The lowest level of the principal inversion was recorded at 6890 m. on November 3, 1910, and the highest at 13,760 m. on August 2, 1906. The lowest temperature, $-73.5°$ C., was registered on February 2, 1911, at 10,390 m., at the level of the inversion.

M. Vincent distinguishes three regions in the atmosphere accessible to instrumental observation:—(1) An upper one, which has been called the stratosphere, where the decrease of temperature is nil, or replaced by an increase; (2) an intermediate zone, where the decrease is at the rate of $0.7°$ C. per 100 metres, whether the conditions be cyclonic or anticyclonic; (3) a lower stratum of variable depth, where the decrease is less than $0.7°$, and is frequently negative; some remarkable inversions are quoted in this portion of the atmosphere. These two lower zones are known as the troposphere. The conditions obtaining in the stratosphere are essentially different from those in the lower regions; the strata are nearly in statical equilibrium, the wind velocity usually weakens, and the direction is uncertain, but the author shows that there are important exceptions to this rule. The trajectories of some of the highest ascents determined by means of a special theodolite designed by M. de Quervain have been discussed.

The Royal Observatory of Batavia has recently published an important contribution to our knowledge of the upper air, including observations made (1) with kites and captive balloon at Batavia between November, 1909, and September, 1910; (2) with kites in the Java and South China seas in January, 1910; and (3) with manned balloon in the years 1910 and 1911. It was during the descent of a balloon on August 5, 1911, that the leader, Lieut. A. E. Rambaldo, unfortunately lost his life. A preliminary report upon these investigations was published in the Proc. Amsterdam Acad., June 25, 1910, and referred to in Nature of November 3 of that year. Among the results of the kite observations we note that the amount of aqueous vapour per cubic metre over Batavia decreases with height, even in the lowest strata. The decrease of temperature with height, up to 1000 metres, is less in the west than in the east monsoon; between 1000 and 2000 metres it is about equal. Over the ocean the decrease is considerable between 0 and 200 metres and exceeds 1° C. in the first 100 metres; above 500 metres it is less than at Batavia. Above 1400 m. the temperature is higher than at Batavia, and the difference probably increases at heights beyond 3000 m. The diurnal change of the vertical temperature gradient differs over land and sea.

The Supplement to the Monthly Weather Review of the Canadian Meteorological Service for 1911 contains a preliminary account of the results of the investigation of the upper air over Ontario by means of balloons and kites commenced during that year; a full description of the apparatus and methods employed, together with a more complete discussion, is reserved until a longer series of observations has been obtained. Registering balloons were liberated on the evenings preceding the "international" days, and the results are given for each 0.5 km. of height, with intermediate points if there were any noteworthy features. The greatest height reached was 20·2 km. on September 9; pressure 43 mm.; temperature −59° C. The lowest temperature, −62°, was recorded at 14·1 km. All the balloons travelled easterly, but as several were lost owing to the proximity of lake or forest, the station had to be moved from Toronto to Woodstock, about eighty miles to the westward. The kite station is at Agincourt, about fourteen miles from Toronto; Dines's kite and meteorographs were used, and good records of pressure, temperature, humidity, and wind direction have been obtained; the highest flight was 7900 ft. above sea-level.

BIRD NOTES.

In the November number of *The Zoologist* Mr. Harvie-Brown, in completing his account of the southern extension of the breeding range of the fulmar which has been in progress for many years, points out that these essentially Arctic birds had established themselves in St. Kilda at least 250 years ago. In 1838 or 1837 they were observed for the first time in the Faröes, nesting on the cliffs of Qualboe in Suderoe, and by 1849 they had colonised Skuor and Great Dimon. From these islands the fumar has invaded, as a breeding species, the Shetlands, the Scottish mainland, and the west coast of Ireland.

To Notes from the Leyden Museum, vol. xxxiv., Nos. 3 and 4, Dr. Van Oort contributes further records of the recapture of birds marked in Holland during 1911 and 1912. Among the species mentioned is the spoonbill, of which one example was taken at Reculvers, Kent, while four others were killed in north-western France. The total number of birds ringed in 1912 is considerably in excess of those marked in 1911.

An article on the haunts of the spotted bower-bird (*Chlamydodera maculata*), contributed by Mr. S. W. Jackson to the October number of *The Emu*, is illustrated by excellent photographs of the "runs," nests, and eggs of these birds. In addition to certain implements purloined from the writer's camp, the objects in one of the bowers included ribs and vertebræ of sheep, toe-bones of emus, fragments of coloured glass, stoppers of sauce-bottles, metal clippings, screws, metal bottle-capsules, a cartridge-case, and numerous pods and seeds. The birds nest high up in leafy trees, but select as look-out stations leafless branches or trees.

In vol. ii., No. 1, of the University of California Publications in Zoology Mr. H. C. Bryant bears testimony to the utility of birds as destroyers of grasshoppers. In July last it appears that grasshoppers were doing considerable damage to alfalfa and vegetables at Los Banos, Merced County, California. An average of about fifteen grasshoppers to a square yard is harmful, but in this instance there were from twenty to thirty. Several kinds of birds were observed to be feeding on the insects, and it was noticed that the local contingent of the former was reinforced from the neighbourhood. The author is led to conclude that although birds cannot be regarded as a trustworthy means for controlling all infestations of grasshoppers, yet they are efficient in preventing many. They can be depended on to protect crops by their war against the grasshoppers. "The failure of birds to check an insect outbreak is evident to all. Their success in preventing insects from becoming abnormally abundant is not so apparent but is no less real." Many birds in this particular case changed their normal feeding habits, and took to preying on grasshoppers, and species usually considered harmful to the agriculturist were commended for their utility.

The food of the pheasant in the Scottish grouse moors forms the subject of a note by Mr. P. H. Grimshaw in *The Scottish Naturalist* for November. Examination of the contents of the crop of a bird killed in Argyllshire, where the heather-beetle (*Lochmoea suturalis*) was unusually abundant during the summer, showed that these consisted chiefly of insects. These included 2286 flies (*Bibio lepidus*), 508 heather-beetles, and six other insects. This leads to the conclusion that the pheasant, like the blackcock, may be reckoned of importance in checking the ravages of the heather-beetle.

Another paper on the food of birds is published as Bulletin No. 44 of the Biological Survey of the U.S. Department of Agriculture. This report, which is drawn up by Mr. F. E. L. Beal, relates to the fly-catching species of North America, referable to the genera Sayornis, Empidonax, Muscivora, Myiarchus, Tyrannus, &c. The contents of the stomachs, or crops, of seventeen species were examined, and it was found that "of thirteen of these species Hymenoptera are the largest element in the diet. Of one species Orthoptera (grasshoppers and crickets) are the leading food; in another Lepidoptera (moths and caterpillars) are the favourites; and in two others Diptera (flies) stand at the head. Hemiptera (bugs) are eaten extensively by some, but naturally the ones taken are the larger flying species. Plant-lice and scales [Coccidæ] have not yet been found in the stomach of any fly-catcher, though one bird was shot on a plant covered with lice, with which its bill was filled."

Several of these birds have been charged with devouring honey-bees, but the accusation is not sustained by the examination of their food; comparatively few of these insects being devoured, and those chiefly drones. The real harm done by these birds is the destruction of predaceous and parasitic Hymenoptera which wage war on injurious insects. R. L.

STOCK DISEASES AND THEIR SUPPRESSION IN SOUTH AFRICA.[1]

MODERN knowledge of trypanosome disease and others of a similar nature can be usefully applied to some of the problems which are in my particular line of research, viz. to diseases of our domesticated animals. I shall mention but two, known probably to you all, and which are of great economical importance—horse-sickness in equines, and blue-tongue in sheep. Long before any expert came in contact with him, the observant farmer quite rightly classed these two diseases in one group. He even went so far as to say they were identical, but here is an opinion which we are not able to support. There are, nevertheless, more similarities than differences in the two; they resemble each other in nature of the cause, both being due to micro-organisms of infinitesimal minuteness, so small that none of our modern microscopes can detect them.

The theory of our modern microscope teaches us that there is a limit to visibility beyond which objects can no longer be recognised. The so-called ultra-microscope, which makes use of a different principle of illumination, and allows the detection of objects varying in the magnitude of a molecule, has in these two diseases failed to enable us to demonstrate an organism so far. It must be there, nevertheless, and we conclude this from the experiment that we are able to transmit the disease by inoculation with blood from a sick to a healthy animal, in which latter, after a definite incubation time, it appears, thus showing

[1] From the Presidential Address delivered before the South African Association for the Advancement of Science, at Port Elizabeth, on July 2, by Dr. Arnold Theiler, C.M.G.

that a development must have followed. It having been demonstrated that the malady was inoculable, it formed the subject of much speculation to explain the observations which the farmers had been collecting ever since they knew it, and which principally apply to the climatic and tellurical conditions under which it appears. You have probably all heard that the farmer interpreted his observations to the effect that the dew is the cause. There is nothing ridiculous in this theory. Remember that our knowledge of micro-organisms as causes of disease is practically only a science of yesterday; remember that the English translation of the name "malaria" for the disease of that name means "bad air," and it is only a few years back that science admitted of such a theory as the probable cause; that is just as our farmers have done and are still doing for horse-sickness.

The observations of the farmer are correct in details. We give them the right interpretation when we substitute for the name "dew" the name "blood-sucking night insect." Under the conditions under which dew is formed horse-sickness and blue-tongue appear most frequently, and these conditions are most favourable for the breeding of mosquitoes and other blood-sucking insects. This being so, the question might be put to us, "But are there any direct proofs to this effect?" If we had all the proofs, we would no longer speak of a theory, and we must speak of a theory until the actual blood-sucking insect has been demonstrated and until the experiments have been made under such conditions that no doubts are left any longer. Indirectly, the theory has been so well founded that the only missing link is the insect itself. The reason why this link has not been demonstrated yet is the fact that we do not know sufficient of all the nocturnal blood-sucking insects of South Africa, of which various genera and many species exist; we do not yet know how to breed and handle them for such delicate experiments as are required to bring the proofs with horse-sickness and blue-tongue. Notwithstanding this, the theory has its practical value, inasmuch as it shows in which way protective measures can be adopted, and what has been said about the destruction of mosquitoes in connection with human malaria applies equally well to the diseases under discussion.

The theory goes still further. Seeing that flying insects must be accepted as being the transmitting agencies, we conclude that there also must be a reservoir somewhere from which these insects obtain the virus. This is perhaps the most interesting point. The horse alone in the case of horse-sickness, and the sheep in the case of blue-tongue, are not sufficient to represent that reservoir. When recovered, the blood of these animals no longer contains any virus. Furthermore, horses, when introduced into a wild country where before there had never been any equines, are liable to contract the disease. Again, the almost "explosion-like" expansion when climatic conditions are suitable does not allow us to conclude that the sick animal alone is responsible, and we naturally ask, "Where does the virus come from?" By analogy with tsetse and human malaria we accept the existence of a reservoir in the shape of a different species of animal, harbouring the parasite of the disease in its blood. Such an animal may be cold-blooded or warm-blooded, a bird or a mammal.

Here, again, we have not yet been able to make further progress. We enter on a different branch of research. It will be interesting work for our zoologists to point out to us the geographical distribution of any such animals, coinciding with the distribution of the disease. Then we might have more hope of proving the theory than there is at present, where we have to work more or less in the dark. It is this theory which justifies the hope that within the districts of the reservoir those diseases will be suppressed one day. Recently an assistant of mine, Mr. Walker, found a parasite in the blood of young ostrich chicks known under the name of *leucocytozoon* and related to the trypanosomes. Whatever the practical outcome of this discovery will be, one conclusion we are entitled to make now, and that is the parasite is transmitted by insects; and should it prove to be the cause of the mortality observed in chicks, the way to combat it is indicated by this conclusion.

Whilst on the subject of suppressing disease, I wish to refer to some other well-known observations made by farmers, the correct interpretation of which has led to important applications. They are in connection with immunity. When horses or sheep recover, they are said to be salted against the disease, viz. to be immune. We expected this to be so by comparison with other diseases of a similar nature, but caused by visible organisms. To this latter group belong those against which modern science introduced methods of preventive inoculation, and by analogy we were entitled to anticipate that a similar possibility would exist in connection with those under discussion. It proved to be the case, and on recognised principles, methods of inoculation for mules as well as for sheep were worked out, which proved to be successful. In the case of horses, however, great difficulties were experienced, inasmuch as these animals showed a much higher susceptibility than mules, a fact which can only be explained by inherited immunity from their sires, which, although susceptible to the disease, have, at least in my experience, never been found to die. The methods in use for mules proved useless for horses. Here the observation of the farmers came to the rescue; they led to deductions which proved to be applicable in the practice.

Long ago farmers had the experience that the so-called salted horses may break down in immunity. They called these relapses, or "*aanmanings*." Subsequently our experience proved the same observations to be correct. Some of the mules and horses which were undoubtedly immune broke down when exposed to natural infection. The virus from such cases was collected, and in several instances it was shown that breakdown in immunity could be produced in almost any salted animals. The experiments showed that there was no actual loss of immunity in the animal affected, but the relapse was due to the different nature of the virus. This means from a biological point of view, the ultravisible micro-organism will also follow the laws of other organisms, viz. that of variability or mutability, but which can show itself to our eyes only by a different virulency in the animal it attacks.

Accordingly more than one variety of horse-sickness organisms exist, and although from a pathological point of view we only recognise one disease, yet there are as many diseases as there are varieties of ultra-visible organisms. At one time we thought that the variation was simply due to the influence of environment, but, based on a number of experiments, we came to the conclusion that the cause of the variability of a particular strain lies in the horse from which it is collected. The host represents, so to say, its environments. The passage through a horse determines whether there will be a decrease or an increase in virulency. This fact established, the further conclusion was made that there must be certain strains or varieties of which the virulency would not be so pronounced, and accordingly that a greater number of animals would recover when infected. This, indeed, proved to be the case. The variability of the organism has now been made use of for the inoculation of horses in connection with the method as applied to mules. The method was introduced into practice last year, and only in the experimental manner; it has not yet stood the brunt of the severe tests of the practice.

The experience just now alluded to teaches us that under the conditions of the practice breakdown in immunity will occur. It remains to be seen to what extent they do occur, or, in other words, what percentage of inoculated horses will be protected against the naturally acquired disease. The same principle was made use of in the preparation of the blue-tongue vaccine, and again recently in the method of inoculation against anaplasmosis of cattle, a disease generally known as gall-sickness. This latter was found to be caused by parasites attacking the red corpuscles of the blood. The remarkable observation was made that two different varieties of organisms could be distinguished under the microscope, and the tests proved that whereas one species was very virulent, the other one was very much less so, and this latter protected an animal to a great extent against the former. The vaccines used against the various diseases therefore represent by no means anything artificial; they are specially selected germs producing the disease in a milder form, which give a great amount of immunity, but by no means a complete one, owing to the existence alongside of still stronger varieties of the same species or genus.

A cure or an inoculation against a disease always appeals to the mind of a layman, and more credit is attached to such an inoculation than to other methods of prevention or controlling the disease which perhaps are more rational but more tedious and cumbersome. A good illustration of this is afforded by red-water, which, as many of you will remember, was introduced into the Cape Colony many years ago. In those days measures were taken to stop its spread, but they were of no use, because the cause of the plague was not then known. Only in the beginning of the 'nineties of the last century was it found in America that it was due to a parasite which lived in the red corpuscles; the parasite developed in the body of a tick, and was transmitted by these to new cattle.

This was as much an epoch-making discovery as Bruce's that the trypanosoma disease was carried by winged insects. The statements of the American men of science were subsequently verified in Cape Colony, and when the attention of South African workers was directed to the presence of similar parasites in the blood of South African stock suffering from various other ailments, then it was only natural to conclude that in their propagation ticks also must be responsible. The conclusion proved to be correct. It was further proved that there also existed the theoretical reservoir; it was found that it was the recovered animal itself which remained infected. This fact, so paradoxical as it appears for healthy animals to spread a disease, explains the permanency of infection on our pasture; although they are immune, they maintain the contamination.

The investigations by Lounsbury into heart-water, a disease caused by an invisible organism which at one time rendered the rearing of cattle and small stock almost an impossibility, more particularly in this neighbourhood, proved definitely that also here ticks were responsible. Once these facts were well established, it was a natural conclusion to expect that the destruction of the ticks would mean the eradication of the disease, just as the destruction of mosquitoes meant the disappearance of malaria. This conclusion at one time had only appealed to a limited number of farmers, and it is even at the present time not sufficiently appreciated. Perhaps it is not scientific enough, or there is not enough mystery about it.

When the terrible disease, East Coast fever, was introduced into South Africa, the presence of a parasite found in the blood corpuscles was soon recognised, and the conclusion had to be drawn that here again ticks were responsible. This also proved correct. After the species of tick which transmitted the disease had been traced, and their life-history was fully understood, and once it had been realised that in this disease, unlike the other caused by intracellular parasite, the immune animal did not represent the reservoir for the virus, it became possible successfully to combat it. In the course of time the most powerful remedy proved to be the dipping tank, which was decidedly the salvation of the Natal farmer, all other methods of stopping the spread in that Colony having failed. For the destruction of the ticks as the root of many evils in stock, the dipping tank must be considered to be the best and most practical means, and its introduction into South Africa is a great scientific attainment.

Not only in the world of micro-organisms, but also in that of higher developed parasites, we shall find our example for demonstrating the utility of the adoption of biological research. I refer to one of the most important farming industries, viz. the breeding of ostriches. We know that one of the main drawbacks are internal parasites, and although the farmer is able to help himself temporarily in a rough and ready way, yet he feels that, in order to combat these pests more successfully, more scientific knowledge is required about the life-history of these worms. As soon as this is established—and I can tell you that good progress has already been made in this connection—practical deduction will be possible in order to build up a rational hygiene for the rearing of the chicks.

So far I have selected my examples in scientific research and practical application out of a group of diseases due to parasites visible to the naked eye, by microscope, or those that can be traced by means of inoculation experiments. We have, so to say, the cause of the diseases in our hands, and can produce and reproduce them at will. This is the one and perhaps the main reason why in the past, in a considerably short time, good progress was made; we were dealing with problems similar to many others already solved. I will now have to mention a subject where the use of the microscope and all transmission experiments into animals failed. It is the disease "Lamziekte" in cattle, to which, in recent years, so much attention has been given by the public, the Press, and Parliament. It has caused terrible destruction, and even threatened to ruin the newly-developed north-western districts.

The investigations carried out so far in conjunction with Mr. Burtt-Davy, the Government agrostologist and botanist, show that we have to deal with toxins which are present in grasses of certain areas. This is at least our theory, and it is well founded; it is, however, by no means new, as it has its analogies in other parts of the world, and explains the observations made by farmers in various parts of South Africa; indeed, it represents the views of many farmers, although not precisely expressed. It is that grasses on certain soils and under certain climatic conditions develop a poison of an accumulative character which only shows its effects on cattle after they have partaken of such grasses for a prolonged period. Actual feeding experiments which have been started on various experimental stations will bring the proof one of these days. The influence of climate and soil has also recently been brought home by experiments undertaken in Natal. Some of you will remember that Mr. Robertson, of Grahamstown, proved in an unmistakable way that the plant *Senecio latifolia*, collected in that part of the country, was found to be very fatal when fed to horses and cattle. The experiments in Natal, carried out on the same class of animals with the same plant, proved harmless.

You will grasp the complexity of these subjects when you remember that, in order to understand and explain them fully, a combination of a number of sciences is necessary, viz. pathology, geology, botany, chemistry, climatology, meteorology, and physiology. Better subjects could scarcely have been found to illustrate how comprehensive investigations may become in a matter which at first sight seems purely and simply a problem for the veterinarian. This point brings me back to some remarks raised before. It is only possible for an applied science, such as that for investigating into the cause of the disease, to progress when the other sciences on which the applied one is based are advancing at the same time or, still better, are ahead of it. This applies strikingly to the case in point. Of the physiological effect of grasses and plants under the various conditions of climate and soil in South Africa we know nothing as yet. I am glad to state that the Minister of Agriculture, to whom I have explained the necessity of such investigations, has promised to add a branch of physiological research on to the laboratory under my control. But an investigation of this nature must be thoroughly undertaken, and in order to be fruitful it must go hand in hand with chemical and biological investigations of the nature of the soil as well.

The necessity for such investigations has frequently been pointed out. Prof. Pearson some years ago advocated the erection of botanical gardens in South Africa in areas representing the various conditions of climate and soil, and one of his strong arguments was the economical importance such establishments would have. Our recent investigations bear him out, and should bring home the value of such institutions. For many years Dr. Juritz preached the necessity of a systematic and thorough chemical survey of the soil of this subcontinent. The conclusions I put before you in connection with the disease caused by plants show you the necessity in the first instance of scientific research into soil and vegetation. But a good deal is required if we intend to make further progress in the understanding of the disease as already described, and of many more not touched at all. The necessity for a general biological survey of all South Africa becomes obvious. Particularly the geographical distribution and seasonal occurrences of plants and animals, the connection of climate and soil with flora and fauna, will have to be thoroughly studied. Hand in hand with this will go the interpretation of the presence and absence of the cause of certain stock diseases.

Fortunately, in the past a great deal has been done by a good many enthusiastic workers. More has yet to be done. Dr. Muir, in his presidential address in Cape Town two years ago, touched on this question, and he pointed out the necessity of a systematic cooperation in which the museums of South Africa could perform the leading duties. I fully agree to this, and I am of the idea that these institutes, similar to the one under my charge, should be centralised, and the work should be undertaken in a definite and well-planned manner, preventing overlapping, and securing complete specialisation in the various branches. We require more: we want a centre for scientific investigation, a central university for South Africa, where research is the leading idea. I speak with emphasis, that South Africa should not wait any longer before establishing such an institute. We men engaged in the application of science feel the want of it in all our undertakings; we require it for advice or assistance in the many problems the solution of which is entirely outside the scope of a single man, who is not always able to keep in line with the new discoveries, and outside his own sphere of work. Nowadays, it is no longer a genius who will only be capable of solving knotty problems; I venture to say that the methods of investigation and research are so far developed that any scientifically trained man with the necessary critical mind, and endowed with patience and perseverance, can tackle these investigations with every prospect of solving them, provided the sciences he has to make use of are sufficiently far advanced to be of assistance to him.

In conclusion, I wish to come back to one of my remarks; that the South African tends to the practical side of scientific problems. If I can give him, after so many theoretical discussions, practical advice, it will be: foster by all means the pure sciences; they are, in the hands of experts, the medium of solving the many economical problems of South Africa.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IN the issue of NATURE of December 5 last attention was directed to the action which the general council of the University of Edinburgh had taken to bring before members of Parliament and others interested in higher education the serious danger with which the universities of Scotland are threatened by the recent interference of the Treasury with their freedom of internal administration. From further information which has reached us, we find that the question of whether or not Scottish universities are to establish composite or inclusive fees is regarded by the council as relatively unimportant. The vital question is whether the Scottish universities, which have hitherto been free so far as their internal administration is concerned, are now to be subject to a State department. The council is not asking that the universities of Scotland should be freed from the responsibility of accounting for their use of public money, but it is desired that the autonomy which has hitherto been a greatly valued characteristic of the Scottish university system should not now be withdrawn.

THE Bulletin of the Massachusetts Institute of Technology for December, 1912, takes the form of "a catalogue of the officers and students, with a statement of the requirements for admission, and a description of the courses of instruction." One of the most interesting of the very complete arrangements of the institute is the opportunity for research afforded in all the laboratories devoted to the more advanced branches of instruction, as well as in the three separately organised research laboratories for physical chemistry, applied chemistry, and sanitary science. We notice also that by a gift in 1909 special research in seismology and other branches of geophysics was provided for. On January 1, 1912, the Hawaiian Volcano Research Association cooperated with the institute to establish an observatory and laboratory at the volcano Kilauea. Work was begun at once, and a suitable building has been constructed with laboratories, a seismograph cellar, water supply, and facilities for physico-chemical investigation of volcanic process. Investigations are carried on by a resident staff, and properly qualified investigators will be received at the observatory for special studies.

IT is announced that a group of some of the largest coal owners of South Wales has decided to start a mining school for the training of colliery officials. Treforest House, Treforest, has been acquired for the purposes of the school, and the post of director of mining instruction is being advertised. It is proposed to make a levy of one-tenth of a penny per ton on the output of the collieries concerned, which will provide upwards of 5000*l*. a year for the maintenance of the school. The scheme is really part of a larger scheme recommended by Prof. Louis, of Newcastle-on-Tyne, on the lines of the mining school at Bochum in connection with the Westphalian coalfield, whereby elementary instruction in mining, given at preparatory schools spread over the whole district, leads up to the higher work in the central mining school. The portion of the general scheme which it is now proposed to develop does not embrace the all-round training necessary for mining engineers, such as that provided for in some of the English universities and at University College, Cardiff. It is much to be hoped that the mining courses now being arranged will not overlap the higher work that comes more strictly within the province of the University College at Cardiff, and that the development of the mining department at that college will not suffer in the future from any want of sympathy and financial support from the wealthy colliery proprietors of our richest coalfield.

The report for the session 1911–12 on the work of the department of technology of the City and Guilds of London Institute has been published by Mr. John Murray. The number of subjects in which examinations were held by the department was 75, the same number as in the previous year, the number of separate classes increased from 4495 to 4552, the largest on record, and the number of students in attendance rose from 52,680 to 53,999. These figures represent the numbers of students of registered classes, receiving instruction mainly with a view to the institute's examinations, but they are only a proportion of the total number of students in applied science and technology, who are in attendance at courses of instruction largely influenced by the work of the department. There can be no doubt, the report states, that the teaching of technology has improved greatly during the past few years; but it is noted that the examiners have still to direct attention to the insufficient knowledge that some candidates possess of the principles of their subjects, and to the lack of practical knowledge shown by others. As regards the preliminary training of the students, the examiners in several subjects comment on the inability of the candidates to write good English, the poor handwriting and spelling, and the unsatisfactory answers to questions involving calculations. The report urges that it is desirable, before commencing the distinctly technical part of their course of training, that the attendance of pupils at day or evening continuation schools in which special provision is made for manual instruction, the teaching of English, and practical science should be further encouraged.

The Department of Agriculture and Technical Instruction for Ireland has issued its programme of technical school examinations for 1912. Both in day secondary schools and in evening technical schools the department has adopted a system of inspection, to the exclusion of written examinations, as a test of efficiency, and has never prescribed written examinations for the purpose of assessing grants for educational purposes. It is not proposed to depart from this policy, which has been attended by excellent results. In past years students requiring some certificate of efficiency have entered for certain English public examinations in science and technology. The recent changes made by the Board of Education in its science examinations, together with other considerations, have led the department to inaugurate the examinations dealt with in the programme. The scheme of examinations is designed to follow courses of instruction extending over four years in the following branches of technical knowledge: commerce, building trades, applied chemistry, electrical engineering, mechanical engineering, domestic economy, art. There will be, in general, two examinations in each course in each of the four years, and the examinations in each course must be taken in the order prescribed. The department will not be concerned with the examination of students other than those intending to take out a course certificate. The syllabuses of examination are based upon the knowledge which may be acquired in following a definite course of instruction in a technical school, though the department will not for the present require attendance at a technical school as a qualification for admission to the examinations.

The Imperial University of Tokyo, the calendar of which for the current session has been received, consists of six colleges of law, medicine, engineering, literature, science, and agriculture. In each college complete arrangements have been made for higher education in accordance with the most modern standards. It is possible here to refer to one or two examples only. Attached to the College of Agriculture are five forests, two in Tokyo Fu, one in Chiba Prefecture, one in Hokkaidō, and one in Formosa. That in Chiba Prefecture, to take one instance, covers an area of about 5358 acres, and is divided into the Kiyosumi and the Okuzan forests, and it is intended for use in practical instruction in forestry, for the investigations undertaken by the professors and students, and to serve as a model of scientific forest management in Japan. The system of scholarships, too, is of special interest. Research and loan scholarships are awarded. The former are intended for graduates of "high scholarship and of sound and strong character" who wish to devote themselves continuously to study and research. Loan scholarships are of two kinds—college scholarships and donation scholarships. A college loan scholarship has a value not exceeding 120 yen per annum, and is for students unable to meet college expenses from their private means. When the holder of a loan scholarship has graduated, he is bound to refund the sum he has received by monthly instalments, so as to complete the repayment within the same number of months as that during which he had been in receipt of the scholarship; and he also pays interest at the rate of 6 per cent. per annum. A donation loan scholarship differs chiefly in being allotted according to the wishes of the donor.

SOCIETIES AND ACADEMIES.

London.

Royal Society, December 5.—Sir Archibald Geikie, K.C.B., president, in the chair.—Dr. J. H. **Ashworth** and Dr. T. **Rettie**: A Gregarine—*Steinina rotundata*, nov. sp.—present in the mid-gut of bird-fleas of the genus Ceratophyllus. This cephaline Gregarine was first observed in the mid-gut of adult examples of *Ceratophyllus styx*, and its life-history has been traced in larvæ and adults of this species, in which it has been found to be common. Examples of *C. farreni* and *C. gallinae* have also proved to be infected, but only sparingly.—G. **Dreyer**, W. **Ray**, and E. W. A. **Walker**: The size of the aorta in warm-blooded animals, and its relationship to the body-weight and to the surface-area expressed in a formula. The conclusion reached is that in any given species of warm-blooded animal the sectional area of the lumen of the aorta (A) is proportional to the body-surface, and can be calculated from the body-weight by means of the formula $A = W^n/k$, where n has the value 0·70 to 0·72, and k is a constant to be ascertained for each particular species.—G. **Dreyer**, W. **Ray**, and E. W. A. **Walker**: The size of the trachea in warm-blooded animals, and its relationship to the body-weight, the surface-area, the blood-volume, and the size of the aorta. Measurements have been carried out on rabbit, guinea-pig, and ptarmigan. These show that within a wide range of weight in any given species of warm-blooded animal, the sectional area of the lumen (T) of the trachea is proportional to the body-surface, and can be calculated from the body-weight by means of the formula $T = W^n/k$, where n has the value 0·70 to 0·72, and k is a constant to be ascertained for each particular species. Since n has now been shown to be 0·70 to 0·72, not only in the case of the blood-volume, the aortic area, and the tracheal area, but also in calculating the surface-area from the body-weight, it follows that the three former measurements are all proportional to the body-surface, and that the formula put forward ($W^n/a = k$) is a rational formula.—Studies of the processes operative in solutions:—(i) E. E. **Walker**: The conversion of ammonia cyanate into urea, especially as influenced by alcohols.—(ii) F. P. **Worley**: (1) The hydrolysis of cane sugar by dilute acids. (2) The hydrolysis of cane sugar by sulphuric acid, with a note on improvements in polarimetric apparatus. (3) The hydrolysis of methylic acetate by acids.—(iii) Dr. H. E. **Armstrong** and F. P. **Worley**: The nature of hydrolytic process.—Dr. R. T. **Beatty**: The direct production of characteristic Röntgen radiations by kathode particles.—A. S. **Russell**: The penetrating power of the γ rays from radium C. Attempts have been made to detect a radiation from radium C possessing a greater penetrating power than ordinary γ rays. A source of 300 millicuries of radium emanation was immersed in a tank of mercury at a distance of 20 cm. below the testing instrument, and sunk in the mercury until the leak in the testing instrument was no greater than the natural ionisation. It was found that the ionisation due to any radiation penetrating 25 cm. of mercury is less than 2×10^{-6} of that due to the unabsorbed γ-ray beam. The absorption of the γ rays was measured also for a great range of thickness of mercury. From 1 cm. to 22·5 cm. absorption took place strictly according to an exponential law. Over this range the intensity is diminished in the ratio of 360,000 to 1. The value of the absorption coefficient (cm.$^{-1}$ divided by the density) was found to be 0·0438, which is very nearly the same as that found by Soddy and Russell for lead, namely 0·0437.—Dr. H. S. **Allen**: The photo-electric behaviour of iron in the active and passive state.—H. B. **Keene**: A determination of the radiation constant. The mean value obtained for the radiation constant equals $5·89 \times 10^{-5}$ erg. cm.^{2} sec. deg.^{4}. The paper contains the calculation of an exact expression for the energy exchange between two radiating coaxial circular apertures; the ordinary approximate expression which applies when the distance between the apertures is great being insufficiently exact in the present case.—C. G. **Douglas**, Dr. J. S. **Haldane**, Y. **Henderson**, and E. C. **Schneider**: Physiological observations made on Pike's Peak, Colorado, with special reference to adaptation to low barometric pressures.—Muriel **Robertson**: Notes on the life-history of *Trypanosoma gambiense*, with a brief reference to the cycles of *T. nanum* and *T. pecorum* in *Glossina palpalis*.

Royal Meteorological Society, December 18.—Dr. H. N. Dickson, president, in the chair.—Prof. H. **Bassett**: Probable utility of salinity observations in the Irish Sea for long-date weather forecasting. The cyclones which reach the British Isles nearly all arrive from the Atlantic, consequently any alteration in the distribution of temperature in the Atlantic may be expected to affect their number and character. The hydrographic investigations which have been carried out in the North Atlantic and in European waters during the past fifteen years have shown that they are affected by a periodic change in salinity and temperature, the period of which is about one year. This change is of such a nature that the water is salter and relatively warmer in the winter and spring months and fresher and relatively cooler in the summer and autumn, the time of maximum salinity depending somewhat on the geographical position. The author described the result of a series of salinity observations which he has carried out in the Irish Sea, and he has found that the salinity changes and the time of their occurrence preceded certain seasonal types of weather. He is therefore of opinion that if monthly observations of the salinities were made at certain stations on the line of the Calf of Man—Holyhead, these would enable forecasts of the general character of the weather over the British Isles and a considerable part of Europe to be given four or five months ahead.—J. E. **Clark**: Air currents at a height of fifty miles, as indicated by the Bolide, on February 22, 1909. This meteor, the brightness of which was at least four times that of Venus, was seen at 7.38 p.m. at a height of fifty-eight miles, and it left a remarkably bright streak in the sky, which was watched by observers in the southern counties for the long period of 104 minutes. The author collected the various observations, and after plotting them on charts came to the conclusion that between 49·5 and 51 miles the streak lay in a west wind of great velocity, and that at 51·5 miles the current was almost from the east with a velocity of about 100 miles an hour. Above this the current changed to south-east and ultimately to south-west, with an increased velocity.—C. **Anthony**: New form of standard barometer.

Royal Microscopical Society, December 18.—Mr. P. E. Radley, vice-president, in the chair.—F. **Enock**: Insect intelligence. Several instances were given from the life-history of spiders and insects which seem to show real reasoning power, and lead to the conclusion arrived at by Lord Avebury, who attributes to insects in degree a certain amount of conscious knowledge. When breeding the larvæ of dragonflies the author has repeatedly observed the nymph on leaving the water crawl up a leaf or stem or some twig, and when it has reached a certain point it rests and suddenly flings out its tail as far as it can, and should it come into contact with anything, it changes its position and again flings its tail out, and continues to do so so long as it comes into contact with a leaf or stem; it changes position until, on flinging out its tail, it does not come into contact—then, and not until then, does it affix its clasping limbs to the leaf or twig preparatory to going through its transformation. From this the author gathers that the nymph has conscious knowledge that it will require a certain amount of space so that its large wings do not come into contact with anything when fully developed.

CAMBRIDGE.

Philosophical Society, November 25.—Dr. Shipley, president, in the chair. Prof. **Hughes**: The gravels of East Anglia. In introducing the subject of the gravels of East Anglia, Prof. Hughes pointed out that too much importance must not be attached to the absolute height and level of the river terraces, first, because of the rise of the valley from its mouth to its source, and, secondly, on account of the earth movements which have affected the area. He showed that there had been considerable depressions in the valley of the Cam since the deposition of some of the existing river silt. Only a small proportion of the flints of which the gravels were chiefly composed were likely to have been derived directly from the Chalk, and very few from the London Tertiaries. They were probably produced on the Miocene land surface over which the Crag sea advanced rapidly, sweeping up the old surface soils, and forming the first deposits of angular flints from which so much of our stained gravel has been derived. The subsequent depression of this area, while adjoining mountain regions were uplifted, would account for the material of the Norfolk cliffs, which might be referred to the action of an ice-laden sea on the land.—Dr. **Marr**: The meres of Breckland. Attention was directed to the small meres of the sandy heaths north of Thetford, situated in chalk. The meres are probably explicable on the view that events happened similar to those observed in other limestone districts, such events occurring as the result of subterranean drainage.—Dr. **Arber**: The earlier Mesozoic floras of New Zealand. A preliminary survey has been made of the specimens of fossil plants collected in New Zealand by Mr. D. G. Lilley, now biologist to Captain Scott's Antarctic expedition, during the recent winterings of the *Terra Nova* in New Zealand waters. Those obtained from Mount Potts in the Rangitata Valley (Canterbury) are particularly important. For many years past it has been asserted that Glossopteris and other members of the Glossopteris flora of Gondwana-land occur in New Zealand at Mount Potts. Among the specimens examined, however, there is no trace of Glossopteris, though another somewhat similar plant is abundantly present, and this has no doubt been mistaken for Glossopteris hitherto. The age of the flora is further unmistakably either Rhætic or Liassic, and thus much younger than the Permo-Carboniferous flora of Gondwana-land.—R. H. **Rastall**: The mineral composition of some Cambridgeshire sands and gravels. Following on a previous and as yet unpublished research on the Neocomian rocks, the author was led to investigate the mineral composition of the Pleistocene deposits of Cambridgeshire, numerous specimens being collected from the Plateau Gravels, the sands of the ancient and of the present river-systems, and from certain surface deposits formed by wind-transport. The chief constituents are quartz, flint, and chalk, with a notable proportion of glauconite and heavy minerals, especially garnet, tourmaline, kyanite, staurolite, hornblende, augite, epidote, zircon, and iron ores. Muscovite was not found except in the plateau sands, a very remarkable fact, which cannot yet be fully explained.—Dr. F. H. **Hatch**: A remarkable instance of complete rock-disintegration by weathering. The material described comes from Diamantina, in the province of Minas Geraes, Brazil, where it is being worked for diamonds. It occurs as a loose sandy deposit in which there are a number of partially disintegrated pebbles, and is sufficiently soft to be dug out with a shovel at the lowest depth yet attained in the open-working. The pebbles consist of quartzite, vein-quartz, steatite, and tourmaline-quartz vein-stuff. The sand is a mixture of colourless quartz and of the fine powder produced by the pulverisation of the steatite fragments. The heavy minerals in the residue obtained by treatment with bromoform are the following:—Zircon, zinc blende, galena, iron pyrites, chalcopyrite, rutile, and tourmaline. The material has evidently resulted from the prolonged weathering of an ancient conglomerate formation.

MANCHESTER.

Literary and Philosophical Society, November 12.—Prof. F. E. Weiss, president, in the chair.—Dr. Henry **Wilde**: Searchlights and the *Titanic* disaster (see p. 471).—H. G. J. **Moseley**: Radium as a means of obtaining high potentials. A radio-active substance which emits β rays should, when insulated, continue to gain a positive charge until a potential of the order of a million volts is reached. Only the fastest β rays should then be able to escape. Experiments have been made to test this point. A small bulb containing radium emanation was supported by a quartz rod in the centre of an exhausted flask. A disc suspended from a quartz spring in the neck of the flask formed a simple attracted disc electrometer. It was found that a bulb of diameter 9 mm. reached a potential of 160,000 volts in the course of a few minutes. A sudden discharge then occurred through the residual gas in the flask, although great care had been taken in obtaining the vacuum. A bulb of diameter 5 cm. charged up much more slowly; no discharge took place, and the final potential, 140,000 volts, was limited by a leak of electricity along the quartz support. The cause of discharge in a high vacuum remains unknown.—C. G. **Darwin**: The interference-phenomena produced by passing X-rays through crystals.

NEW SOUTH WALES.

Linnean Society, October 30.—Mr. W. W. Froggatt, president, in the chair.—T. D. A. **Cockerell**: Australian bees. No. I. A new species of Crocisa, with a list of the Australian species of the genus. A new species from West Australia is described. Two species attributed to Australia are excluded, Amboina being their correct habitat.—T. D. A. **Cockerell**: A small collection of bees from Tasmania. Thirty-seven species are known from Tasmania, including two described as new in this paper. Tasmania is much richer in bees than New Zealand, and systematic collecting and observation are desirable.—W. L. **Distant**: Synonymical notes on some recently described Australian Cicadidæ.—A. M. **Lea**: Revision of the Australian Curculionidæ belonging to the subfamily Cryptorhynchides. Part xi. Deals with a group of small and highly polished weevils, sparsely represented in Australia, but abundantly in New Guinea and the Malay Archipelago. The abdomen and hind legs of some of the species are peculiar. Five genera (one new) are noted, and fourteen species (five new).—R. H. **Cambage**: (1) Notes on the native flora of New South Wales. Supplementary lists to part viii. Camden to Burragorang and Mount Werong. (2) Notes on the native flora of New South Wales. Part ix. Barraba to Nandewar Mountains and Boggabri. The Nandewar Mountains are of botanical interest. Their altitude is about 5000 ft., while they are situated about ninety miles west of the Main Divide. One Queensland plant, *Pultenaea setulosa*, was found there which had not previously been recorded from New South Wales; also several southern plants which had not been recorded as occurring north of the Hunter Valley. Amongst the latter is a Victorian species, *Asterolasia correifolia*, var. *Muelleri*, known in the Buffalo Mountains and in the Kiandra district, and its discovery on the summit of the Nandewara extends its known range 400 miles northerly. The question is discussed as to how it may have developed. To show the effect of climate on plant-distribution, it is pointed out that around Boggabri, at elevations ranging from 800 to 1200 ft., about 36 per cent. of the species noticed occur in Tasmania, while on the Nandewars, at altitudes ranging from 3000 to 5000 ft., in a distinctly mountain or cool climate, about 60 per cent. of the plants found are represented in Tasmania.

CALCUTTA.

Asiatic Society of Bengal, November 6.—W. **Kirkpatrick**: The marriage ceremony and marriage customs of the Gehara Kanjars. The marriage ceremonies and marriage customs of the Gehara Kanjars, who are an endogamous section of an aggregate of tribes of a gipsy-like character scattered all over northern India, are remarkable for two or three survivals. The authors find a strict observance of the primintive exogamic law, a proper recognition of the occupational origin of the tribe, a reverence for the tribal token, beater ordeal by way of consulting the oracle, and mock combat between the bride's and bridegroom's respective parties.—Dr. P. C. **Ray** and Rasik Lal **Datta**: Isomeric allylamines.—Rasik Lal **Datta**: The preparation and decomposition of monochloro- and dichloro-benzylamines.—Jitendra Nath **Rakshit**: Action of stannic chloride on phenylhydrazine.

BOOKS RECEIVED.

Grundzüge der allgemeinen Phytopathologie. By Prof. H. Klebahn. Pp. ii + 147. (Berlin: Gebrüder Borntraeger.) 4.80 marks.

Fortschritte der naturwissenschaftlichen Forschung. Edited by Dr. E. Abderhalden. Siebenter Band. Pp. ii + 268. (Berlin and Vienna: Urban and Schwarzenberg.) 15 marks.

Abhandlungen über den mathematischen Unterricht in Deutschland veranlasst durch die Internationale Mathematische Unterrichtskommission. Edited by F. Klein. 25 parts. (Leipzig and Berlin: B. G. Teubner.) Various prices.

The Entomologist's Log-book and Dictionary of the Life-Histories and Food Plants of the British Macro-Lepidoptera. By A. G. Scorer. Pp. vii + 374. (London: G. Routledge and Sons, Ltd.) 7*s*. 6*d*. net.

The History of the Collections contained in the Natural History Departments of the British Museum. Vol. ii., Appendix. By Dr. A. Günther. Pp. ix + 109. (London: Longmans and Co., and others.) 5*s*.

Catalogue of the Mammals of Western Europe (Europe exclusive of Russia) in the Collection of the British Museum. By G. S. Miller. Pp. xv + 1019. (London: Longmans and Co., and others.) 26*s*.

Catalogue of the Collection of Birds' Eggs in the British Museum (Natural History). Vol. v. By W. R. Ogilvie-Grant. Pp. xxiii + 547 + plates. (London: Longmans and Co., and others.) 2*l*. 7*s*. 6*d*.

Catalogue of the Chætopoda in the British Museum (Natural History). Part i. By Dr. J. H. Ashworth. Pp. xii + 175 + plates. (London: Longmans and Co., and others.) 27*s*. 6*d*.

The Genus Iris. By W. R. Dykes. With 47 coloured drawings by F. H. Round, 1 coloured plate of seeds by Miss R. M. Cardew, and 30 line drawings by C. W. Johnson. Pp. 245. (Cambridge University Press.) 6 guineas net.

Miners' Nystagmus: its Causes and Prevention. By Dr. T. L. Llewellyn. Pp. xix + 158. (London: The Colliery Guardian Co., Ltd.)

The Centenary of a Nineteenth-century Geologist, Edward William Binney, F.R.S. Pp. 58. (Taunton: Barnicott and Pearce.) 2*s*. 6*d*. net.

Syllabus der Pflanzenfamilien. By Prof. A. Engler. Siebente, wesentlich umgearbeitete Auflage. By Prof. E. Gilg. Pp. xxxii + 387. (Berlin: Gebrüder Borntraeger.) 6.80 marks.

Memoirs of the Geological Survey of Ireland. The Interbasaltic Rocks (Iron Ores and Bauxites) of North-East Ireland. By Prof. G. A. J. Cole and others. Pp. vi + 129. (Dublin: H.M.S.O.; London: E. Stanford, Ltd., and others.) 3s.

The Lichens of the Swedish Antarctic Expedition. By O V. Darbishire. Pp. 74 + 3 plates. (Stockholm: Lithographisches Institut des Generalstabs; London: Dulau and Co., Ltd.)

The Works of Aristotle. Translated into English under the Editorship of J. A. Smith and W. D. Ross. De Motu Animalium. De Incessu Animalium. By A. S. L. Farquharson. (Oxford: Clarendon Press.) 2*s*. net.

A History of Chemistry from the Earliest Times till the Present Day. By the late Prof. J. C. Brown. Pp. xxx + 543. (London: J. and A. Churchill.) 10*s*. 6*d*. net.

Mathematische Instrumente. By Prof. A. Galle. Pp. vi + 187. (Leipzig and Berlin: B. G. Teubner.) 4.40 marks.

Beobachtungen über Strandverschiebungen an der Küste des Samlands. II., Brüsterort. By Dr. R. Bruckmann. Pp. 15 + plates. (Leipzig and Berlin: B. G. Teubner.) 1.20 marks.

Veröffentlichung des Königlich Preuszischen Geodätischen Institutes. Neue Folge. No. 54. Untersuchungen über die Gezeiten der festen Erde und die hypothetische Magmaschicht. By Dr. W Schweydar. Pp. 58. (Potsdam; Leipzig: B. G Teubner.) 3.50 marks.

The Problem of the Gasworks Pitch Industries and Cancer. The John Howard McFadden Researches. Pp. 48. (London: J. Murray.) 6*d*. net.

The Passing of Morbid Anatomy. The Harveian Oration for 1912. By Sir J. F. Goodhart, Bart. Pp. 32. (London: J. Murray.) 1*s*. 6*d*. net.

Heredity and Memory, being the Henry Sidgwick Memorial Lecture, 1912. By Prof. J. Ward. Pp. 56. (London: J. Murray.) 1*s*. 6*d*. net.

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THURSDAY, JANUARY 2, 1913.

RACES OF MANKIND.

Homo Sapiens. Einleitung zu einem Kurse der Anthropologie. Autorisierte Übersetzung aus dem Italienischen. By Dr. Giuffrida-Ruggeri. Pp. viii + 198. (Vienna and Leipzig: A. Hartleben, 1913.) Price 5 marks.

THE author of this work, who holds the chair of anthropology in the University of Naples, has come in recent years to occupy a place among the leading anthropologists of Europe. He has taken a part in every one of the recent international discussions relating to the origin of man and the separation of mankind into modern races. On every occasion he has shown himself to possess a wide and intimate knowledge, a clear and simple style, and an exceedingly well-balanced judgment.

The present work, which has been honoured by a translation into German, is marked by all these virtues, and will serve as an excellent and systematic introduction to all those problems which at present occupy the attention of anthropologists. The chief problem concerns the single or multiple origin of modern races of mankind. The author, after discussing all the evidence produced in favour of a multiple origin—the facts produced by Klaatsch, by Kollmann, by Ameghino, by his colleague Sergi, who fills the chair of anthropology in Rome, comes to the conclusion that all modern races are descendants of a common stock and are single in their origin. Modern races all belong to the one species, *Homo sapiens*, but it is a species made up of a collection of well-marked varieties, each variety being, in his opinion, a potential species. The characters revealed by the fossil remains of extinct races convince him that in the past there have been several species of mankind, *Homo sapiens* being the only surviving species. As regards the number of varieties or subspecies of modern races of mankind, the Neapolitan professor quotes with approval the statement of Prof. von Luschan, of Berlin, "That it is as difficult to give their number as it is to estimate how many angels could dance on the point of a needle"!

The principles which underlie the knowledge we apply to the evolution of man must rest on the laws of heredity. Hence in the first chapter of this book, which has the merit of very moderate dimensions, Prof. Giuffrida-Ruggeri discusses the problems of heredity and seeks to apply Mendel's law to man, depending especially in this chapter on the writings of Bateson, Davenport and Hurst. He is apparently inclined to believe that mutation has been an active factor in the differentiation of modern races, but is sceptical of convergence having played any part in human evolution.

It would take us too far afield to summarise the remaining chapters of the book; it is sufficient to state again that the work is the best introduction yet published to the modern problems of man's origin.

A. K.

IRRITABILITY OF PLANTS.

Die Reizbewegungen der Pflanzen. By Dr. Ernst G. Pringsheim. Pp. viii + 326. (Berlin: Julius Springer, 1912.) Price 12 marks.

DR. PRINGSHEIM disarms criticism by stating in his preface that he is writing rather for the layman than for his professional colleagues. We fancy, however, that there will be few plant physiologists who will peruse the book without gathering something from it, here and there an out-of-the-way fact, or a new impression—the result of skilful handling of his material on the part of the author.

It is true that the book does not, perhaps, add much that is new to our stock of knowledge, and that sometimes one is disposed to dissent from the conclusions to which Dr. Pringsheim arrives. But there is a freshness about the whole work, coupled with a sense of first-hand acquaintance with the experimental evidence under review, which lifts it far above the level of a mere compilation.

Indeed, it is open to question, perhaps, whether the book, as a whole, will not appeal rather to the physiologist than to the non-botanical reader, in spite of the intention conveyed by its author. Some of the pages dealing with geotropism are good reading, and really provide an excellent summary of the principal results at present attained. The layman, however, will probably want to know what Piccard's methods (p. 49) of investigation on geotropism were, and it is not easy, without a previous familiarity with the apparatus, to follow the discussion of Haberlandt's investigations on similar lines. The statolith theory of geotropic perception is very briefly discussed, and some of the difficulties in the way of its acceptance are pointed out; the judicial conclusion is reached that we have not yet heard the last word on it.

The treatment of periodic movements is interesting, but perhaps more open to criticism than most of the rest of the book. The distinction between truly irritable movements and growth, which may accompany them, seems scarcely to be kept in sight sufficiently.

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Several of the specially interesting examples of plant-movement receive careful treatment, and amongst them chemiotaxis is fairly fully discussed, but no very satisfactory conclusion is arrived at—a result which is quite justified by, and in accordance with, the present state of knowledge.

In the general summary there occurs an excellent suggestion as to the general attitude to be maintained towards the whole subject of irritability by a wise investigator.

Although it may not be possible as yet to give a complete or satisfactory explanation for the irritable manifestations of life, or of the manner in which they are produced, it is nevertheless on the suggested lines that advance may still be most profitably made. Even if we are as yet ignorant of many things in chemistry and physics which are necessary to the solution of the problems, it is better to search in those directions than to delude ourselves with psychical explanations which are no real explanations at all, but mainly serve to bar real advance by substituting elusive phantasy for ascertainable fact. At the best, they may be useful in checking too ready dependence on crude mechanistic hypotheses. For this is apt to be the sin of those who desire to run along the road of the "exact sciences" faster than the way is securely built, or even exactly traced.

J. B. F.

COPPER SMELTING.

Modern Copper Smelting. By Donald M. Levy, Pp. xii + 259. (London: C. Griffin and Co., Ltd., 1912.) Price 10*s.* 6*d.* net.

THE book consists of the lectures given by the author before the senior students of metallurgy at the University of Birmingham, considerably extended, and is based partly on a study of the practice as conducted at some of the most important copper-smelting works in America, and of the records of the advances in the metallurgy of copper contained in recent technical literature. Incorporated in it are also the personal experiences of the author during a stay at the works at Anaconda and at others in Tennessee.

In the first four lectures are given brief accounts of the history and uses of the metal and of the preliminary preparation of the ores for smelting. As regards the roasting of ores, the modern type of furnace is indeed described, but the space devoted to this important operation might be extended with advantage in the next edition of the book.

The use of the reverberatory furnace, which, not long ago, was considered by some to be passing into obsolescence and was almost everywhere being displaced by the blast-furnace, has, during recent years, again come to the front on account of its suitability for the smelting of fine ores.

New furnaces of extraordinary length and other dimensions have been erected at Anaconda and elsewhere, and are worked with a greater economy of fuel and labour than the smaller furnaces which formerly were universal in this country.

Copper-smelting generally, however, is conducted on a much less magnificent scale than at the Anaconda works, and it would have been well if the description of the furnaces and practice there had been supplemented by an account of the practice and type of furnace that would be best adapted for works of moderate size. This remark also applies to lecture vi., on blast-furnace practice, in which the Anaconda plant again receives chief attention.

The lectures on bessemerising and copper-refining contain a good summary of these processes, but are wanting in one or two details.

The foregoing criticisms are offered in a friendly spirit, as the book is a good one, an excellent summary of modern copper-smelting practice, and should be in the hands of every student of this subject.

W. G.

PERSONAL AND PUBLIC HEALTH.

(1) *Perfect Health for Women and Children.* By Elizabeth S. Chesser. Pp. xi + 276. (London: Methuen and Co., Ltd., n.d.) Price 3*s.* 6*d.* net.

(2) *Hypnotism and Disease: a Plea for National Psychotherapy.* By Dr. Hugh C. Miller. Pp. 252. (London: T. Fisher Unwin, 1912.) Price 5*s.* net.

(3) *Modern Sanitary Engineering.* Part i., House Drainage. By G. Thomson, M.A. Pp. xv + 266. (London: Constable and Co., Ltd., 1912.) 6*s.* net.

(1) THE author's experience as a woman doctor has frequently shown to her how necessary it is to women, especially mothers, that they should be supplied with information which will be of service to them in health and sickness; and the book which she has written aims at supplying intelligent women with such useful information. The simple facts of hygiene, properly understood and practised, cannot fail to prevent much disease, and a knowledge of the domestic treatment of common ailments will in many cases avert serious complications. Miss Chesser has to be commended for having treated a wide subject in such a sound, common-sense and practical manner as will make the book appeal to every class of reader, both lay and medical. The author

does not mince matters when she finds fault with the unhygienic practices of the present day; and the work is full of good, telling sentences, such as, "if women paid as much attention to their teeth as they do to their complexions, they would be 50 per cent. healthier and better looking."

The right provisions for the healthy child are summarised by the writer in her directions to give the child the right sort of food and make him eat it properly; provide fresh air for him night and day; teach him how to breathe and how to play; train his mind and character; do not "coddle" either in clothing or in diet.

(2) This volume presents the main features of psychotherapy in a form suitable for the intelligent lay reader, and it forms an interesting and instructive work which should appeal to the physician as well as to the layman. The *rationale* of hypnotism and the scope of suggestion in medical practice are clearly defined. The object of hypnotism, as taught in this book, is to render the mind receptive and capable of influencing function; and a merit of Dr. Miller's exposition is its moderation in statement.

With the enlarged understanding of the subject it seems likely that we shall in the future see an increased evidence of the suitable employment of psychotherapeutics; for our highest medical authorities recognise that mental healing has a firm basis of truth and fact, and that it may be properly and safely employed by skilled doctors who have the gift and power to use it, for every mentally healthy individual can be brought under its influence. It is the absence of this power and the failure to cultivate it which has often led to the easier expedient of administering bromides, massage, &c., to neurasthenics, when hypnotic suggestion would constitute a better treatment of the patient.

This treatment by mental methods does not necessarily involve hypnosis, and it includes the very important subject of re-education of self-control. The main object of the book is to show that what the "quack" (religious or medical) can do by fraud, delusion, or mystery can be done by the honest physician who works through the mind on the body, without descending to deception in any shape or form.

(3) This book presents a useful statement upon the practical sanitation of the dwelling, in so far as the provisions for drainage are concerned. As would be expected, seeing that the writer has been lecturing upon sanitary engineering at the Royal Technical College, Glasgow, for some twenty years, the facts are well put, clearly expressed and concisely dealt with in a handy, well-illustrated volume.

OUR BOOKSHELF.

Internaciona Biologial Lexiko en Ido, Germana, Angla, Franca, Italiana ed Hispana. By Dr. M. Boubier. (Jena: Gustav Fischer, 1911.) Pp. vi+73. Price 1.50 marks.

In 1901 the Delegation for the Adoption of an Auxiliary International Language was founded. This delegation, while approving generally of Esperanto, decided that certain reforms were needed, and as Esperantists would not agree to these, there have resulted two languages, or rather dialects, namely, Esperanto and Ido, of which the latter possesses the advantage that it can be printed without the use of specially accented letters, besides other advantages in the matter of simplicity.

In the "Internaciona Biologial Lexiko," Dr. Boubier has drawn up a vocabulary, for the purposes of this language, of the principal terms used in biology, with their equivalents in German, English, French, Italian, and Spanish. Most of these terms are mere modifications of ordinary biological nomenclature adapted to the grammatical requirements of Ido. In many cases an intelligent reader could guess the meaning of these words, though he would have difficulty in writing them, and in this respect the present nomenclature is better than that used for some of the words in common use.

It is to be hoped that these attempts to find a satisfactory auxiliary language will not result in chaos, for while we have already two rivals in Ido and Esperanto, attempts are being made in other quarters to restore Latin in a modified form to its original position as the language of the learned world, and if science students are still to be required to pass examinations in Latin on the ground that it is *the* fundamental language, they will certainly show some reluctance in learning a second auxiliary language differing greatly from Latin. It will remain to be seen whether Ido is sufficiently near Latin to appeal to the pupils of our public schools.

Who's Who, 1913. Pp. xxx+2226. Price 15s. net.

Englishwoman's Year Book and Directory, 1913. Edited by G. E. Mitton. Pp. xxxi+412. Price 2s. 6d. net.

The Writers' and Artists' Year Book, 1913. Pp. viii+147. Price 1s. net. (London: A. and C. Black.)

Some idea of the comprehensive character of the latest issue of "Who's Who" may be gathered from the fact that it contains 25,000 biographies of men and women in some way distinguished. Due prominence is given in the collection to successful workers in science, and not only are British men of science dealt with, but also those of foreign countries. The editor of this indispensable work of reference may be congratulated upon keeping it up to date and maintaining all its useful characters.

"The Englishwoman's Year Book" serves admirably to show the increasing share educated women are taking in the useful work of the world. Parents will find helpful guidance here as to the education of their daughters and the opportunities available for them to obtain remunerative labour later in life. The volume should be in the hands of every woman worker.

"The Writers' and Artists' Year Book," in addition to being a handy index to periodical literature, places at the disposal of writers, artists and photographers useful guidance in the matter of disposing of their work satisfactorily.

The Beginner in Poultry. The Zest and the Profit in Poultry Growing. By C. S. Valentine. Pp. x+450. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 6*s*. 6*d*. net.

By the time the "beginner" has read this book he might well think himself something more than a beginner. The keynote of the work is sympathy, and once possessing that, it is hard indeed if one cannot make a success of any hobby in live stock. Naturally, the suggestions as to management are more suited to the States than to this country, but the reader who wishes to take a broad view of aviculture, and is already conversant with the ins and outs of the daily routine, will find much food for reflection by a careful study of many of the chapters. We would specially commend to the powers that be section 22 on poultry schools. When one knows of the hard struggle for existence some of our educational work has had, and the scant support our own Board of Agriculture can offer, it makes one feel somewhat envious of the magnificent grants that are so freely available on the other side. The writer of this notice has had the good fortune to take part in some of the courses alluded to, and knows that such experts as are engaged at Cornell and Corvallis, &c., are past masters in the poultry world, and heartily endorses much of what the book says on this question.

The work contains some 450 pages, and is profusely illustrated, though several of the reproductions are not quite up to the high standard one usually sees in the American Press. Perhaps the author's other book, "How to Keep Hens at a Profit," should be read first. The present volume is rather for the library or student; it does not cater for the exhibitor. Its value is rather to the thinker, and he who thinks is he who rules.

The Montessori System in Theory and Practice. By Dr. Theodate L. Smith. Pp. vii+78. (New York and London: Harper Brothers, 1912.) Price 2*s*. 6*d*. net.

In the review of Madame Montessori's recent book describing her method of scientific pedagogy as applied to child education in "The Children's Houses," published in NATURE on September 26 last (vol. xc., p. 99), some account was given of the system. It is sufficient to say of Dr. Smith's little volume that it provides a convenient introduction to the methods advocated by Madame Montessori, and some reports of American experience of their adoption.

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.*]

British Forestry and the Development Commission.

It is more than two years since the Development Commission obtained its fine grant of 500,000*l*. yearly for five years. There have been Parliamentary grants in addition; thus 900,000*l*. was available the first year. Said *The Times*: "The Development Fund is a remarkable departure from the *laissez-faire* policy which has so long dominated the proceedings of British Governments." It was early announced that one of the chief objects of the Development Commission was British forestry, *including the purchase and planting of land*. One small piece of poor ground in Scotland represents all the land that has yet been acquired in Britain; and foresters are beginning to inquire if we have really broken away from the bad traditions of the past. British forestry has never had such an opportunity as this half-million grant. Will anything practical be done before it is too late and the grant come to an end, because nothing practical has been achieved? It is true that there have been useful educational grants; and promises of loans for forestry, on liberal terms, to "local authorities or other responsible bodies": but this, without State forestry, is putting the cart before the horse. As is well known, the communal forests on the Continent carry a class of forest inferior to the State forests, and they are only kept up to this standard by either State supervision or their management by State forest officers, combined with the stiffening effect of the better managed State forests in their midst.

For fifty years British State forestry has been standing still. Excellent schemes have been prepared. There have been innumerable Parliamentary Committees and reports! Three quite good British schools of forestry training have been established, and, alas! abolished, in spite of the excellent training they were giving. There remains now but one State forest school, the useful institution for instructing woodmen in the Forest of Dean. In the successive abandonment of these Government forest schools we see the want of a permanent forest authority to defend them against the vacillations of political control.

The onus of this failure in forestry—and forestry is perhaps the greatest of the modern arts—lies in the hesitancy of the Britisher to accept State forestry. It is tolerably certain that no material progress in British forestry will ever be made without State forestry, which is the kernel and pith of the whole business. There are two reasons why we must accept State forestry. Only the State can obtain money at a low enough rate of interest ($2\frac{1}{2}$ or 3 per cent.) to make forestry pay in this climate of low sun-power. Only the State has the "unending life," viz. a life long enough for successful forest management. A private owner cannot be expected to plant trees for the public good with only the prospect of an uncertain 2 or 3 per cent., going to his son, his grandson, or even his great-grandson. Further, forestry, like so many other industries, must be done on a large scale to yield good returns.

Most of the opposition to State forests is no doubt due to ignorance of what they are. To the uninitiated they may look much like the wild forest that, in parts of the world, has to be largely cut down to make way for settlement. But, to those who know, the modern cultivated forest is very different. It yields more timber, and its uses "for the healing of the nations" are manifold and of the first importance. The nearer it comes to our doors, the better for us; and happily also the better for the cultivated forest. The wild forest is generally a distant business, not entering into the daily life of the people, a life which the forest can so enrich and enlarge.

The avowed object of the Development Commission when instituted was "to apply State methods long proved successful in other countries and in the Colonies to the development" of these islands. But the Development Commissioners have now formally stated that their *general policy is adverse to State forestry* (Report for period ending March 31, 1911). No reasons are given for the adoption of a decision so strangely at variance with the rest of the civilised world. Germany spends 7,000,000*l*. a year on State forestry. The Prussian Forest Department between 1867 and 1892 acquired 329,850 acres of waste land for re-foresting at a cost of about 1,125,000*l*., besides granting substantial bounties for planting to private landowners, and giving in one year (1893) about 32,000,000 young trees for planting to private owners of woodlands (Dr. Nisbet). France, with a much smaller forest area, spends half a million yearly on State forestry.

Every country in Europe has its State forests in a more or less advanced condition of development. Most instructive, in this respect, is the excellent forest work of Japan. With a cool head and free hands, unfettered by the traditions of Western Europe, it has calmly appropriated what is good in Western civilisation and rejected the bad. Japan adopted State forestry in the earliest days of its civilisation. It is now spending more than 250,000*l*. yearly on its State forests, and it has some 100 million young trees in its State forest nurseries. The returns show an average of sixty-two million trees planted yearly in the State forests! There are free grants of trees and subsidies for private tree-planting. Instruction in forestry permeates the whole educational system, from the universities to the village schools.

Writing as one who has borne a prominent share in one of the largest works of constructive forestry in recent times, I say without hesitation, let the Development Commissioners frankly accept State forestry and do as the rest of the world. If, thirty years ago, Cape Colony had hesitated at practical State forestry it would not occupy the position it does now.

Cape Colony (now under Union the Cape Province) has spent considerably more than 1,000,000*l*. on its forestry, and it is now producing, within its own borders, the greater portion of the timber imported from abroad at a cost of between 300,000*l*. and 400,000*l*. yearly. Cape Colony has wisely held that it is too poor a country to go on paying out this large sum yearly for imported timber.

Though so little has yet been done for practical forestry in Britain, the Irishman has made his voice heard with the happiest results! He has established an epoch in the history of British forestry with the decision of the Development Commission that "State afforestation on a small scale may be started in Ireland immediately." According to the last returns that have reached me, there has actually been acquired for forest purposes in Ireland an area of more than 7000 acres.

It is a serious reflection that Great Britain, year after year, is spending some twenty-five million pounds sterling on imported timber and forest products, a considerable portion of which could be grown on the waste lands of these islands.

Sir William Schlich, in one of his admirable publications on British forestry ("Forestry in the United Kingdom," p. 23), says: "From time to time suitable tracts of land come into the market and there is, in my opinion, no reason why the State should not acquire such land for re-foresting."

Though little has been done for Scotch forestry, for England and Wales there has been even less. Indeed, no beginning of practical State forestry has yet been made in England and Wales. The mountains of Wales, the Weald of Kent, the Sussex Downs, still show vestiges of their ancient wild forests; and here is the best field (near industrial centres) for the more productive modern cultivated forest. There is no reason, except national improvidence, why the Welsh mines should continue to draw the greater part of their pit props from France; or why the Weald of Kent and the Sussex Downs should not have their ancient beauties restored and become once more a source of local wealth and the joy to the Londoner that the beautiful forests near Paris are to the Parisians. Nowadays it is these accessible forests, close to industrial centres, that yield the best returns, some of them in France and Germany from 2*l*. to more than 3*l*. per acre per year of net revenue. Not very long ago it was remarked to me by a French forest expert that these forests near Paris, financially, were carrying the distant Alpine forests on their backs!

There are considerable areas of poor land within twenty or thirty miles of London that, at a reasonable expenditure, could be turned into rich forests, like the Beech forest of the Chiltern Hills. In the Highlands of Scotland, and on the Welsh mountains, there are climatic difficulties (too frequent mists, too little sun), bogland, and peat. But the south-east of England is free from these climatic troubles. It is everywhere within the climatic limits of vigorous and easy tree growth. Let us not forget that in going from the north of Scotland to the south of England we go half-way to middle Italy and Portugal, where the sun-power gives those enormous yields of timber that are the wonder of foresters in more northern climates, 20 tons of (air-dry, seasoned) wood, or 700 cu. ft. per acre per year.

There are 36,000 acres of heath, waste, or poor pasture land in Kent, Surrey, and Sussex. Labour, especially during the winter months, is abundant. Forest work is of the healthiest kind possible. Nowhere in the world do we see men of finer physique than the small farmers and villagers of Germany, who, in the winter, when other work is scarce, find their salvation in the health-giving forest.

Some 10 per cent. of the industrial population of Germany draw their livelihood from the forest, and Sir William Schlich has computed ("Forestry in the United Kingdom") that under any general scheme of State forestry for the British Isles, there would be employment for some two and a half million labourers in winter, and parts of spring and autumn. Here are far-reaching issues. Parliament has voted the money to put them to the test. And yet we allow insular prejudice to block the way to State forestry, which is the essential feature of modern scientific forestry in other countries. D. E. HUTCHINS.

Ridley, Kent, December 17.

The Recent Foraminifera of the British Islands.

I AM proposing, with my collaborator, Mr. Arthur Earland, to prepare a Monograph of the British Foraminifera, the work of Williamson being now in serious need of being brought up to date. With this object in view we are sending a preliminary schedule of questions relative to the shore sands of the British Islands to clergymen and medical men at coastal towns and villages at intervals of a few miles all round the coast. As these gentlemen are strangers to us, I should be very glad to hear from any persons living near the coast who would be willing to receive from us a copy of the schedule and a statement of our preliminary needs. The services which we ask of observers round the coast do not involve any serious trouble, and, of course, no expenses will fall upon those who are willing to assist us.

EDWARD HERON-ALLEN.

33 Hamilton Terrace, London, N.W.

POPULAR NATURAL HISTORY.[1]

(1) MR. SWANTON'S work on plant galls will be welcomed by a wide circle of readers, since it appeals to both the botanist and entomologist. In it the former will find a ready means of identifying the gall-producers which claim his attention, whilst the latter will value the interesting details of insect life-histories. Descriptions are arranged under the headings of gall-producing insects, and chapters are also devoted to growths produced by mites, nematodes, and fungi. The remaining half of the work is occupied by a very complete catalogue of British plant galls, botanically arranged. In the endeavour to cover the whole ground the author has included growths which can scarcely be regarded as galls in the accepted sense. Thus the "Reed Mace" fungus (*Epichloe typhina*) is a mere mass of mycelium outside the plant, there being no hypertrophy of the tissues. It should also be noted that the galls on alder roots are caused, not by *Frankiella alni*, but, as Miss Pratt has shown, by the bacterium *Pseudomonas radicicola*, though the growths may afterwards become infested by the hyphomycete. Bottomley has shown that the similar "galls" on the roots of bog myrtle are produced by the same bacterium.

The work is illustrated by thirty-two plates, of which sixteen are reproductions of excellent colour drawings by Miss M. K. Spittal, and there are also more than thirty text figures.

A male spider near the edge of a web in which the female is at the centre. From "Spiderland."

The author is to be congratulated on a work of great utility and general excellence.

(2) To the majority of the human race spiders are repulsive creatures. They are for the most part devoid of that beauty of form and colour which often ensures a favourable reception to other members of the so-called lower creation. He would, however, be a soulless person who, after reading Mr. Ellis's work, did not regard spiders with respect if not with admiration. As shedding an interesting light on the struggle for existence it is worthy of note that some spiders which resemble ants lay but three or four eggs, whilst less defended orb weavers may lay twelve hundred.

We hesitate to cast a doubt on the wonderful reasoning powers, and especially on the great maternal affection, which the author sees so con-

[1] (1) "British Plant-galls." A Classified Text-book of Cecidology. By E. W. Swanton. With Introduction by Sir Jonathan Hutchinson, F.R.S., and sixteen coloured plates by Mary K. Spittal. Pp. xv+287. (London: Methuen and Co., Ltd., n.d.) Price 7s. 6d. net.

(2) "Spiderland." By R. A. Ellis. With Photographs and Drawings by the Author. Pp. xxii+198. (London: Cassell and Co., Ltd., 1912.) Price 3s. 6d. net.

(3) "Elementary Entomology." By E. Dwight Sanderson and Prof. C. F. Jackson. Pp. vii+372. (Boston and London: Ginn and Co., n.d.) Price 8s. 6d.

(4) "Butterflies and Moths at Home and Abroad." By H. Rowland-Brown. Pp. 271+21 full-page plates. (London: T. Fisher Unwin, 1912.) Price 7s. 6d. net.

stantly exhibited by his subjects, but we confess that our faith in these attributes is of the weakest. The female Lycosid may carry her own young, but she will also carry any other young family indiscriminately, and the author refrains from telling us that *Atypus affinis* will devour her own brood should they unduly delay their departure from the parental abode. The elaborate nest once begun by Agelena will be carefully completed and guarded, whether the eggs are removed or not. Mr. Ellis tells us that his book is primarily intended for young folk, but it will undoubtedly be of interest both to the naturalist and the general reader.

(3) In this work the authors have provided a text-book for beginners undertaking a course of elementary entomology. The book is divided into three sections, the structure and growth of insects, descriptions of species typical of the orders, and a section containing a series of laboratory exercises, together with a key to the orders and information concerning the apparatus and methods employed in collecting and preserving. We have rarely seen a work in which so large an amount of information is compressed into so small a space, and the text is well and profusely illustrated. Such errors as we have found are but few, and detract little from the general usefulness of the work. The statement that the mouth parts of Lepidoptera are so formed as to preclude injury to vegetation is scarcely correct, since at least two African Noctuids do no small damage to peaches by piercing the skin and sucking the juices, whilst the Australian *Ophideres fullonica* attacks oranges, and, as pointed out by Francis Darwin many years ago, has the proboscis specially modified in adaptation to its habits. The statement that all moths are night flyers seems to require some modification.

So long as there is no universally accepted classification of the Insecta we must refrain from too great comment on this portion of the work, though we think it would have been better to point out the sexual differences in the tarsi of the Nymphalidæ and Lycænidæ, and the Erycinidæ should find a place in even a condensed table. Compared with the general utility of the work these are, however, but small matters, and will doubtless be amended in a second edition, which we fully expect will soon be required.

(4) The author of this work has drawn upon his wide and lengthy experience of collecting to provide an extremely pleasant and readable account of a selection of European Lepidoptera. We confess to a feeling of satisfaction that the work tends to lead the young lepidopterist away from the narrow insularity so long and painfully associated with the old-fashioned British collector. The inflated value often placed on British examples of species which may be pests on the Continent is essentially unscientific. For the collector who can extend his field to the Continent Mr. Rowland-Brown's work provides just the information which will awaken and maintain a healthy interest in the subject.

In criticising the coloured plates one must bear in mind the low cost of the volume, and if the figures are not always typical of the best in lithographic art they are at least free from that crudeness of execution which is not always absent from many more costly productions. Whilst we find no fault with the work itself we trust the author's well-known talents, both as a writer and a naturalist, will soon find expression in a volume of a more advanced type.

NATURAL AND SYNTHETIC RUBBER.

UNDER the above title an interesting address was delivered by Dr. F. Mollwo Perkin before the Society of Arts on December 11. After briefly reviewing the history of the development of the indiarubber industry and the nature of the processes used in extracting the natural product and in vulcanisation, an account was given of the recent synthetic processes by which the manufacture of artificial rubber on the large scale has become a commercial possibility. In the process of the Synthetic Products Co. isoprene is made from fusel oil, which is fractionated so as to give *iso*amyl alcohol, $CH(CH_3)_2{\cdot}CH_2{\cdot}CH_2{\cdot}OH$, which is converted into the chloride, $CH(CH_3)_2{\cdot}CH_2{\cdot}CH_2{\cdot}Cl$ by the action of hydrochloric acid and then into the dichloride $C(CH_3)_2Cl{\cdot}CH_2{\cdot}CH_2{\cdot}Cl$ by the action of chlorine, under specially controlled conditions; the dichloride obtained is passed through a tube heated at 470° and filled with soda-lime, whereby it is converted into isoprene, which can be polymerised to rubber by means of small quantities of sodium.

The only difficulty in the way of this process is the cost of the raw product, amyl alcohol, which is about 140*l*. per ton. On this account, Prof. W. H. Perkin, with E. H. Strange, F. E. Matthews, and Prof. Fernbach, devised a process for obtaining butyl alcohol cheaply, from which butadiene could be obtained. By the employment of a certain organism, it was found possible to ferment starch, and, more recently, sawdust, so as to obtain butyl alcohol and acetone, the latter being sold, thus cheapening the cost of the butyl alcohol. The butyl alcohol is chlorinated in the same way as the *iso*amyl alcohol, and by similar treatment with soda lime yields butadiene, $CH_2{:}CH{\cdot}CH{:}CH_2$, which on polymerisation gives a rubber which, although not chemically identical with the polymerised isoprene, has all the properties of natural rubber in regard to elasticity and behaviour towards sulphur on vulcanisation.

An account was also given in the lecture of the processes devised by the firm of Friedrich Bayer, of Elberfeld, and of the interesting fact discovered by Prof. Harries that the presence of a small quantity of rubber ozonide very much increases the rapidity of polymerisation of isoprene and its derivatives.

In discussing the question of the competition of natural and synthetic rubber, it is pointed out that "at present prices and with the present supply and demand there is no reason, provided synthetic rubber is as good as natural rubber, why the two should not exist side by side." But the rubber planter is bidden take heed of the lesson taught by the fate of the natural alizarin and indigo industries and consider possibilities of improving the yield of natural rubber by better methods of tapping, coagulation, the study of agricultural conditions, and possible improvements by fertilisation and the suppression of insect pests, which play havoc with the young trees. It is a significant fact that the Badische Anilin und Soda-Fabrik has agreed to put by 1,000,000*l*. for research in connection with synthetic rubber, just as nearly 1,000,000*l*. was expended by the same firm in research before synthetic indigo was placed on the market.

MOVEMENTS OF GLACIERS.[1]

THE seventeenth report of the Commission Internationale des Glaciers makes its appearance for the year 1911, in conformity with the decision at the Stockholm meeting, without waiting for laggard documents. We learn from it that on the Swiss Alps the majority of the glaciers are still decreasing, probably in consequence of the hot summer of 1911, only three showing signs of an advance, the reason of which remains to be discovered. In the Eastern Alps the observations include eight groups out of twelve, and these show that the fairly general advance of 1910 has not been maintained. In the Italian Alps the retreat, except in a few cases, has been general, as in the previous years, that of the southern end of the Brenva Glacier (Mt. Blanc) having been sixty metres.

The report from the French Alps has not yet been received, but it is not likely to differ materially from the others, so that in this chain the diminution which began about half a century ago has now continued considerably longer than the time which was supposed to be its average one. Of the Scandinavian glaciers, four out of the five observed in Sweden show a marked advance. In Norway a larger number has been studied—in Jotunheim twenty-seven, and in different parts of western Norway twenty-three. In the former district only two show an advance, the remainder being in retreat. In the latter about half the Jostedalsbræ are moving one way and half the other, but the Okstind (five) and two of the Frostis (three) are advancing.

The report, owing to early publication, does not include returns from Russia, Asia, and America, so that general conclusions cannot be drawn; but we may perhaps infer that no marked change is likely to be indicated. The value, however, of summarised systematic observations such as these is very great, because they form the first step—and a very long one—in ascertaining the causes which bring about these periodic oscillations of the ice-streams.

T. G. B.

[1] "Les Variations Périodiques des Glaciers." xvii Rapport, 1911. Rédigé par Charles Rabot et E. Muret. (Extrait des "Annales de Glaciologie," t. vii., pp. 37-47.) (Berlin: Borntraeger Frères, 1912.)

THE PROTECTION OF ANCIENT MONUMENTS.

THE last report of the Inspector of Ancient Monuments, Mr. C. R. Peers, with an introduction by the First Commissioner, Earl Beauchamp, describes the limitations under which the work of the Department is conducted at present. The existing Acts are merely permissive, and the State can exercise no supervision, except with the consent, and indeed by the desire, of the owner. Earl Beauchamp believes that his Department should be invested with the power of intervention when monuments are suffering from neglect, or are threatened with actual damage or destruction, a view in which all antiquaries will concur.

Even under the present restrictions much useful work is being done. The most important operations were at Carnarvon Castle in anticipation of the investiture of H.R.H. the Prince of Wales, in the course of which much ancient work was cleared and repaired. At the Chapel Royal, Holyrood, the discovery of the foundations of an ancient church, with apparently contemporary interments, has disproved the legend that the palace was founded in 1124 on a site till then uninhabited. At the Tower of London the Bell Tower and the turret flanking the Byward Gate had been repaired. At Old Sarum the excavations conducted by the Society of Antiquaries have disclosed the plan of the Castle buildings.

Among the most interesting buildings placed in charge of the Department during the year were the Old Machar Cathedral at Aberdeen; the Gateway Tower of Chester Castle; Richard III.'s Tower at Carlisle; Kirby Muxloe Castle in Leicestershire; and the Bishop's and Earl's Palaces at Kirkwall.

Good progress has been made in the preparation of the County Inventories of Historical Monuments, of which five volumes have been issued, and scientific inquiries are in progress for the prevention of decay in stone-work. It may be hoped that Parliament will soon find time to complete the measures for the adequate protection of historical monuments throughout the country.

NOTES.

THE names of few men associated with scientific work appear in the list of New Year Honours. Three fellows of the Royal Society are among the recipients of honours, namely Mr. Francis Darwin, upon whom a knighthood is conferred; Dr. A. G. Bourne, Director of Public Instruction, Madras, who is made a Knight Commander of the Order of the Indian Empire (K.C.I.E.); and Dr. W. R. Dunstan, director of the Imperial Institute, who has been appointed a Companion of the Order of St. Michael and St. George (C.M.G.). Other names of men known in the scientific world are Sir Frank Crisp, a new baronet, for many years treasurer and vice-president of the Linnean Society, and honorary secretary of the Royal Microscopical Society from 1878 to 1889; Dr. R. W. Philip (knighthood), distinguished by his work on the etiology and treatment of tuberculosis; Mr. S. Stockman (knighthood), chief veterinary officer to the Board of Agriculture and Fisheries; Dr. W. G. Liston (C.I.E.), director of the Bacteriological Laboratory, Parel, and senior member of the Plague Research Commission; and Prof. P. J. Brühl (I.S.O.), Civil Engineering College, Sibpur.

The President of the Board of Agriculture and Fisheries has appointed an advisory committee to advise the Board on questions relating to the elucidation through scientific research of problems affecting fisheries. The committee will be composed of the following:—Mr. H. G. Maurice, Mr. F. G. Ogilvie, C.B., Commander M. W. C. Hepworth, C.B., Prof. G. C. Bourne, F.R.S., Prof. J. S. Gardiner, F.R.S., Prof. A. Dendy, F.R.S., Prof. W. A. Herdman, F.R.S., Prof. A. Meek, Dr. A. E. Shipley, F.R.S., Dr. E. W. MacBride, F.R.S., Dr. W. Evans Hoyle, Dr. S. F. Harmer, F.R.S., Dr. G. H. Fowler, and Dr. E. J. Allen. Mr. H. G. Maurice, the assistant secretary of the Fisheries Division of the Board of Agriculture and Fisheries, will act as chairman of the committee, and Mr. A. T. A. Dobson, of the Board of Agriculture and Fisheries, as secretary.

The Research Defence Society has lately opened a bureau and exhibition at 171 Piccadilly, opposite Burlington House. The windows display a good collection of pictures, photographs, charts, and lantern-slides; apparatus for anæsthetics; germs in test-tubes; specimens of tsetse-flies and mosquitoes; books, pamphlets, and leaflets. They serve to remind "the man in the street" of the immense importance of experiments on animals to the welfare of mankind, and the great saving of human and animal life and health already achieved. Among the pictures is a large engraving of Fildes's "The Doctor," presented to the society by the artist himself. Leaflets are distributed outside. The bureau is in charge of a young lady, who receives signatures and contributions, and enlists new members and associates. The exhibition is quietly attractive to all passers-by.

It is with regret that we have to record the death of Mr. J. Rowland Ward, the well-known taxidermist, which took place at his residence, Restmore, Boscombe, Hants, on Saturday, December 28, 1912. Mr. Ward, who succeeded to the business started by his father, Henry Ward, was, we believe, the first to raise taxidermy to the rank of a fine art, and to replace the old-fashioned "stuffing" process by modelling the form of the animal, and then covering the "manikin" with the skin. And not only was he the inventor of this method, but the work of his firm has ever since maintained that high standard of excellence which has rendered the name of Ward famous throughout the world. The deceased gentleman was, indeed, a born artist, possessing almost unrivalled skill in modelling animals, and if his energies had not been otherwise fully occupied there is little doubt that he could have attained eminence as a sculptor. In addition to mounting individual animals or their heads, Mr. Ward devoted special attention to big groups of animals, the first of which was a "Combat of Red Deer," shown at the London International Exhibition of 1871. For this and other exhibits of the same nature, as well as for the excellence of his work as a general taxidermist, Mr. Ward received a number of gold medals and other awards. In addition to his business as a taxidermist, Mr. Ward published numerous works on big game and sport. He was, moreover, himself an author, and his "Records of Big Game" and "Sportsman's Handbook," which have passed through several editions, are invaluable both to the sportsman and to the naturalist. Mr. Ward leaves a widow, but no family.

The death is announced, at ninety-one years of age, of Dr. P. Redfern, formerly Regius professor of anatomy and physiology at Queen's College, Belfast.

Mr. J. B. Tyrrell, of Toronto, Canada, a member of the council of the twelfth International Geological Congress, to be held in Toronto in August next, is in London for a short time, stopping at the Hotel Victoria, Northumberland Avenue. He asks us to state that while in London he will be glad to furnish information to anyone who purposes to attend the meeting of the congress.

On Monday, December 23, the millionth visitor to the Zoological Gardens, Regent's Park, during 1912 passed the turnstile. This is a record attendance, and bears forcible testimony to the appreciation by the public of the improvements which have been effected during the last few years in the gardens. The fortunate individual who completed the million was awarded a free pass to the gardens for 1913.

Mr. Edward Tyer, well known as a telegraphic engineer, and by his inventions in connection with the system of block signalling on railways, died on Christmas night in his eighty-third year. Mr. Tyer was a fellow of the Royal Astronomical Society, and also an associate (1861) of the Institution of Civil Engineers, under its original charter, a member of the Institution of Electrical Engineers, and a fellow of the Royal Microscopical and Geographical Societies.

The Commonwealth Government has entrusted Prof. A. J. Ewart, professor of botany in the University of Melbourne, with the investigation of the plants collected during the recent Northern Territory exploring expedition, and has appointed Dr. A. Morrison, formerly Government Botanist of West Australia, to assist in the work. Dr. Morrison will reach Melbourne shortly, and it is hoped that the material available will be sufficient for the preparation of a flora of the Northern Territory.

We learn from *The Times* that M. Liard, rector of the University of Paris, announced at a meeting of the council of the University held on December 27 that the Marquise Arconati-Visconti has decided to supplement her previous gift of 20,000*l.* by a further gift of 20,000*l.* to be devoted "to the benefit of the Faculties of Science and of Letters." It has been decided to use the money for the erection of an Institute of Geography to be built by the side of the Oceanographical Institute, endowed by the Prince of Monaco.

The Museum News for December, issued at Brooklyn, New York, gives a full account of the unrivalled collection of specimens of ancient Chinese cloisonné which has been recently presented to the Central Museum by Mr. S. P. Avery. A complete catalogue of this splendid collection has been prepared by Mr. J. Getz, and is accompanied by a full description of the elaborate processes by Mr. S. W. Bushell.

THE November issue of *The National Geographic Magazine* is remarkable for the large series of excellent coloured photographs which accompany two important articles on modern Russia. The first of these, by Mr. W. W. Chapin, is entitled, "Glimpses of the Russian Empire"; the second, by Major-General A. W. Greely, on "The Land of Promise," gives an interesting account of a journey across Siberia, and describes the enormous bodies of emigrants who are rapidly occupying a region of immense fertility. "Slowly but surely," he observes, "the fuller, freer life of Asiatic Russia is bringing into higher and harmonious relations with its environment the godlike soul of man."

IN *L'Anthropologie* for September–October last, L'Abbé H. Breuil, MM. S. Gomez and C. Aguilo continue their important series of studies of primitive art in the Palæolithic caves of Southern Europe with a description of those recently found at Alpéra, 270 kilometres from Madrid. These drawings exhibit several notable peculiarities. They are nearly all representations, probably magical in intention, of hunting scenes, in which the drawings of human figures, usually thin and elongated, with occasionally pronounced steatopygy, depicting their weapons—bows, arrows, and lances—are peculiarly interesting. In one picture two dames, perhaps of high rank, appear dressed in wide, probably ornamented, petticoats. As some of the figures have been retraced, it is not easy to decide their relation to works of art of the same or similar types, except the conclusion that they probably belong to the earlier Quaternary period. It is to be hoped that this series of valuable contributions to prehistoric archæology will soon be republished in a permanent form and in English.

THE "Live Stock Journal Almanack" for 1913 maintains the high level characteristic of that publication, as well as its wealth of pictorial illustration. The contents include nearly sixty articles, notably one by Lord Northbrook on agricultural societies. Others relate to most of the British breeds of horses, cattle, sheep, and pigs. The least satisfactory is one on the relationships of the different breeds of horses and the ancestry of the group, the author evidently possessing but an imperfect acquaintance with his subject.

IN *Naturwissenschaftliche Wochenschrift* of December 15, 1912, Dr. Killermann-Regensburg gives an account, with illustrations, of pictures of the walrus, the bison, and the elk by Albert Dürer. All three are in the Sloane library at the British Museum; those of the bison and elk having been apparently brought to light but recently by Mr. Harry David, who described them in the first part of the *Jahrbuch der K. preussischen Kunstsammlungen* for 1912. In the early part of the sixteenth century, and indeed up to 1550, bison still survived in Prussia, Hungary, and Siebenbürge, so that Dürer may well have seen a living example. Apart from prehistoric sketches, his picture is the earliest known portrait of the bison.

FROM the time their existence was recorded by Mr. Boulenger, in 1900, the presence of hair-like appendages in the males of certain frogs has been a puzzle to naturalists. A possible clue to their function is suggested by Dr. Bashford Dean in vol. xxxi., art. 29 (pp. 349–351), of the Bulletin of the American Museum of Natural History. The suggestion is to the effect that these hairs may serve to retain the coils of spawn in cases where—as in the midwife-toad (Alytes), which does not, however, develop hairs—they are carried on the bodies and thighs of the males. It is mentioned that hair-like vascular structures are developed on the ventral appendages of the lungfish Lepidosiren, which also possesses the brooding habit.

To *The Victorian Naturalist* of November, 1912, Mr. J. A. Kershaw communicates some interesting particulars with regard to the breeding habits and young of the platypus. Three burrows on the Hopkins River were dug out in the presence of the author, one on October 26, 1911, and the other two on October 22, 1912. From the first was obtained a female with two recently hatched offspring, and from the others eggs, a pair in one case and a single one in the other. When the first female was taken a young one was clinging to the belly so tightly that some little effort was required to detach it; its fellow had fallen off unobserved when the parent was dragged from the trench. None of the burrows had an entrance below the normal water-level, and in some cases the entrance was so high up on the bank that it would be submerged only by very exceptional floods. After the eggs are hatched the female parent remains for some days with the young in the burrow, which she blocks with earth in several places, probably as a protection against flood-water, or possibly against enemies.

MESSRS. H. E. JORDAN and K. B. Steele have published an interesting account of their work on the intercalated discs of heart muscle in *The American Journal of Anatomy* (vol. xiii., 1912, 151). Mr. H. E. Jordan had reached the conclusion in a previous paper, from his study of the discs in the heart muscle of humming birds, that these discs were not intracellular elements marking cell boundaries as maintained by Zimmermann and others. In the present paper, which is a comparative study in the microscopy of cardiac muscle, the authors adduce evidence in support of the contention of Mr. Jordan. They maintain that the discs are to be interpreted in terms of local contractions in the muscle fibrils, and that this explanation accounts for the great variety in formation and structure (of the discs) which is found. Further, they hold that the presence of these discs seems to be related in some way to the function of rhythmic contraction which is characteristic of cardiac muscle. In support of this hypothesis they advance the following facts. (1) The discs are absent in the heart of the mammalian fœtus, but they increase in number with age; (2) they are located in lines corresponding roughly with the axes of the heart muscle mesh; (3) they are generally found present in greatest abundance in hearts of rapid beat; and (4) they are also present in the striated muscle of the media in the proximate (beating) end of the pulmonary arteries; for example, in those of the mouse.

WE have received the report of the Bristol Museum and Art Gallery Committee for the year ending September 30 last, and congratulate the committee and the director on a year of steady progress in all departments. New cases have been provided for the birds, reptiles, amphibians, and fishes, and these groups of vertebrates have been completely re-arranged and placed in their natural place relative to the collections of invertebrates so well exhibited in the Dame Emily Smyth room, opened last year. This work completes the re-organisation of the zoological galleries, which must now rank as some of the most attractive in the provinces. A scheme for the reorganisation of the geological and mineralogical collections has been prepared, but cannot be carried out in its entirety until new cases are provided. We hope that the appeal made in this report will meet with an adequate response, for the collections contain much valuable material, *e.g.*, the series of Coal Measure fossils from the Bristol and Somerset coal beds, which, as pointed out in this report, is most complete, and must, for some time, remain unique owing to many of the mines having been closed down since they were collected. It is gratifying to note the increased use which has been made of the museum by students and by teachers and pupils of schools. The committee is alive to the educational value of museums and art galleries, and it is a pleasure to record the success which has attended its efforts to make the institution a real educational asset to the city.

DR. FELIX OSWALD recently presented to the Royal Geographical Society an account of his journey last winter from the Victoria Nyanza to the Kisii highlands. His primary object was to ascertain the geological nature of the locality where Mr. D. B. Pigott, shortly before his unfortunate death while hunting, found a jaw-bone of Dinotherium. Dr. Oswald, however, also investigated considerable areas of unmapped country in the Kavirondo and Kisii districts, and reconnoitred in the extensive tracts left uninhabited through the ravages of sleeping-sickness. He has also carefully studied the natives of the country east of the Victoria Nyanza, and made many references to the beautiful flora of the region. He drew a comparison between the successful ruling of this large and recently hostile country by a handful of Englishmen with the domination of the Romans in Britain, and described with welcome appreciation the way in which the land is governed by the district commissioner, two officers and a doctor, living at Kisii, which was chosen as the administrative centre as being outside the range of the tsetse-fly. Dr. Oswald has brought back collections of fossils, Neolithic implements, insects, shells, and certain plants, besides geological and topographical maps, and photographs all as the result of only two months' work in the field.

IF from the vertices of a triangle perpendiculars be drawn on a straight line, and if from their feet perpendiculars be drawn on the opposite sides, these perpendiculars meet in a point called the orthopole. Mr. W. Gallatly has published a short pamphlet on the properties of the orthopole, based partly on Prof. Neuberg's work and partly on his own. His address is 5 Hampton Place, St. Marychurch, Torquay.

MESSRS. B. G. TEUBNER, of Leipzig, have forwarded their new catalogue of works on mathematics and natural philosophy, comprising books issued by them in these departments between April, 1908, and July, 1912. The catalogue is beautifully got up, and contains portraits of Leonard Euler as well as of the principal contributors to the Mathematical Encyclopædia and other publications.

THE use of algebraic formulæ for indicating the prices of goods in an actual price list appears to be somewhat of an innovation, but it has been introduced into the new catalogue of spectroscopic apparatus issued by Messrs. Adam Hilger, Ltd., of 75A Camden Road. A feature of greater importance is the excellence of the descriptions and illustrations of the apparatus with which the catalogue deals.

SUPPLEMENT No. 25, vol. xi., of the Communications from the Physical Laboratory at Leyden (this supplement being a reprint of article V. 10 of the *Encyklopädie der Mathematischen Wissenschaften*), by Prof. H. Kamerlingh Onnes and Dr. W. H. Keesom, consists of a most elaborate and extensive monograph on the equation of state. Together with its exhaustive references to the original literature, its table of contents and its author and subject indexes, this monograph forms a most valuable addition to science, and will be heartily welcomed by all workers in physics and physical chemistry. Prof. Kamerlingh Onnes is the recognised authority in this field of investigation, a position which he has won by thirty years of continuous and systematic theoretical and experimental work. It would be natural, therefore, to expect that this volume (extending to nearly 350 pages) would contain a masterly treatment of the subject, and it may be said at once that an examination of its contents more than justifies the expectation. The subject is discussed from every possible aspect, and includes a very full treatment of the theoretical as well as the experimental side of the problem. For many years to come the present monograph will be an indispensable work of reference for every physicist and chemist. We have also received Communications Nos. 127, 130, and Supplement No. 25 to Communications Nos. 121–132. These deal with researches on the isotherms of diatomic gases and their binary mixtures, on the second virial coefficient for diatomic gases, and on the Hall effect and changes in resistance in metals and alloys at low temperatures.

AN article on "The Essential Oils," including an account of the materials and methods of perfumery, is contributed to *Knowledge* for December by Mr. H. F. Slack. Written in a popular style, it still contains a large array of accurate technical information, which will provide profitable reading for the trained chemist as well as for the lay reader.

UNDER the unassuming title of "Studies of Chinese Wood Oil, β-Elaeostearic Acid," Dr. R. S. Morrell describes in the Chemical Society's Journal a series of experiments which represent the starting-point of a new era in the study of "drying oils." This particular oil, when exposed to light, deposits a crystalline glyceride $(C_{18}H_{31}O_2)_3C_3H_5$, which absorbs oxygen with extreme facility, and possesses all the essential properties of a drying oil. But on account of its high melting-point, 61–62° C., it can be separated in a state of chemical purity, and provides for the first time a homogeneous material for the accurate scientific study of the "drying" process. The free acid of the glyceride and five of its salts are described in the paper. It is a remarkable fact that the ethyl ester, unlike the glyceride, does not possess the property of setting.

EXCEPTIONAL interest attaches to Prof. Kipping's papers on organic derivatives of silicon, issued in the November number of the Chemical Society's Journal. The most recent papers deal with silicane-diols of the type $SiX_2(OH)_2$. These compounds possess in a remarkable degree the property of forming anhydrides. Thus diphenylsilicanediol, $SiPh_2(OH)_2$, gives compounds such as the diols—

$$HO.SiPh_2.O.SiPh_2.OH,$$
$$HO.SiPh_2.O.SiPh_2.O.SiPh_2.OH,$$

and the oxides—

$$O\Big<\begin{matrix}SiPh_2.O\\SiPh_2.O\end{matrix}\Big>SiPh_2 \text{ and } O\Big<\begin{matrix}SiPh_2.O.SiPh_2\\SiPh_2.O.SiPh_2\end{matrix}\Big>O.$$

These are formed by the removal of water from two, three, three and four molecules of the original diol. Such compounds are undoubtedly typical of a tendency amongst silicon compounds to form chains and rings of alternate silicon and oxygen atoms, which are nearly as stable as the "all-carbon" chains of organic chemistry. This tendency serves to explain the prolific character of oxidised silicon, which gives rise to derivatives only less complex than the carbon-compounds of organic chemistry.

ON December 18 Mr. W. J. A. Butterfield delivered a lecture on coal gas before the Institute of Chemistry, at University College, London. The requirements of a public gas supply were first discussed, the principal points being minimum cost per heat unit, strong smell to facilitate detection of leaks, a luminous flame, and innocuous combustion products. The growth and magnitude of the gas industry here and abroad were then dealt with, the world's production of town gas in 1912 being estimated at 620,000 million cubic feet, for the production of which about 60 million tons of coal would be consumed. As by-products, 30 million tons of coke, 3 million tons of tar, together with ammoniacal products equivalent to about 550,000 tons of sulphate of ammonia, would be sold. As regards the annual consumption of gas per head of population, London heads the list with more than 8000 cubic feet. The predominant use of gas at the present day was stated to be for heating purposes. From this point of view present-day requirements of a gas supply in this country were characterised by (1) a gross calorific power of 540 to 580 B.T.U. per cubic foot; (2) specific gravity between 0·4 and 0·5; (3) oxygen required for complete combustion to be between 1·0 and 1·1 volumes of the coal gas, but the fluctuations in each of these to be restricted within narrow limits for any one district.

MESSRS. WILLIAMS AND NORGATE have just published the first number (January) of *The British Review*, with which is incorporated *The Oxford and Cambridge Review*. The aim is stated to be "to provide a periodical that shall be in the forefront of the world's movements, showing what there is to observe in mental and moral advancement." Among the articles in the January issue are:—"My Views regarding True and False Science," by Count Leo Tolstoy; "Bristol University and Some Reforms," by Mr. F. M. Atkinson; and "Huxley and the Catholic Faith," by Mr. Cecil Chesterton.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR JANUARY:—

Jan. 5. 2h. 37m. Mercury in conjunction with the Moon (Mercury 5° 41′ N.).
,, 7h. 36m. Mars in conjunction with the Moon (Mars 4° 25′ N.).
,, 15h. 34m. Jupiter in conjunction with the Moon (Jupiter 5° 11′ N.).
8. 4h. 27m. Uranus in conjunction with the Moon (Uranus 4° 4′ N.).
9. 7h. 32m. Mercury in conjunction with Mars (Mercury 0° 47′ N.).
10. 22h. 29m. Venus in conjunction with the Moon (Venus 1° 28′ N.).
11. 3h. 4m. Mercury in conjunction with Jupiter (Mercury 0° 13′ S.).
13. 9h. 35m. Mars in conjunction with Jupiter (Mars 0° 47′ S.).
14. 20h. 0m. Neptune at opposition to the Sun.
17. 18h. 46m. Saturn in conjunction with the Moon (Saturn 6° 14′ S.).
21. 14h. 7m. Neptune in conjunction with the Moon (Neptune 5° 24′ S.).
23. 14h. 0m. Uranus in conjunction with the Sun.
28. 20h. 0m. Saturn stationary.
31. 19h. 30m. Mercury in conjunction with Uranus (Mercury 1° 23′ S.).

A BRIGHT METEOR REPORTED.—Two correspondents of *The Daily Dispatch* (December 21) report the appearance of what was probably a meteor of exceptional brilliancy at 10.50 p.m. on December 18. One describes it as a long, brilliant, bluish light, "about thirty yards long," and tapering to the "tail," around which was a peculiar pale golden glow. Stationed at Handforth, a village about nine miles due south of Manchester, this observer saw the meteor in the southern sky, and states that it appeared to fall slightly during its flight, which lasted eight seconds. The second observer states that the sky was so poor that no stars were visible from where he was, although the moon shone through the mist, yet the meteor was so bright as to remind him of a great rocket. He describes it as a great white light, with a brilliant head and a long, spreading, and shimmering tail, which cut its way across the whole expanse of the sky. From his position in Manchester the meteor appeared to travel in a direction slightly north of west from a point not far from south. Further details of this phenomenon should prove of interest.

EPHEMERIS FOR GALE'S COMET, 1912*a*.—In No. 4618 of the *Astronomische Nachrichten*, Dr. Ebell publishes a daily ephemeris, extending to February 5, 1913, for Gale's comet. The comet is now high up in Draco, and is reported to have a nucleus of magnitude 10 or 11. The following is an extract from Dr. Ebell's ephemeris, which is based on the elements published in Lick Observatory Bulletin No. 218:—

Ephemeris 12 *h.* (*M.T. Berlin*).

1912–13	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	Mag.
Dec. 27	17 17·6	+64 54·5	0·2245	0·1374	8·6
31	17 30·0	+68 14.8	0·2389	0·1426	8·6
Jan. 4	17 45·5	+71 34·9	0·2529	0·1490	8·8
8	18 5·9	+74 51·8	0·2663	0·1568	8·9
12	18 35·1	+78 1·0	0·2792	0·1661	9·0
16	19 20·1	+80 53·9	0·2917	0·1766	9·1

THE SPECTRUM OF NOVA GEMINORUM, NO. 2.—Having secured a number of photographs of the spectrum of Nova Geminorum, No. 2, Messrs. Adams and Kohlschutter give their measures and discussion of the radiations in No. 4, vol. xxxvi., of *The Astrophysical Journal*. The plates were taken with the Cassegrain spectrograph attached to the large reflector (80-foot focus) at Mount Wilson, and cover the period March 22–May 27. During this period considerable changes took place in the spectrum of the nova, and these are discussed at some length in the paper: the chief nebula line, λ 5007, was first certainly seen on April 6.

The authors have measured some hundreds of apparently dark and bright lines in the spectrum, and give observed wave-lengths for four groups of negatives, each group covering a definite period; thus in addition to the wave-lengths for the centres of the bright bands they give wave-lengths for the dark lines which some observers consider to be only parts of the structure phenomena of the bright bands. Generally speaking, the wave-lengths for the centres of the latter agree fairly well with those determined from the Madrid spectra, and published in NATURE on April 25 (No. 2217, vol. 89, p. 201), and, possibly, might bear the same interpretation. Ten wave-length values of bright bands are given as reasonably identified with helium lines, although it is somewhat difficult to see, from the list of observed wave-lengths, exactly the type of line, or band, some of them represent. The presence of radioactive substances in the nova's atmosphere is not indicated by the Mount Wilson photographs, and the authors consider that the presence of nitrogen, as suggested by Mr. Wright in the case of Nova Lacertæ, is probable but scarcely proven.

The widths and displacements of the bright and dark hydrogen lines are also discussed, and the paper is accompanied by reproductions of a number of excellent spectrograms.

OBSERVATIONS OF SATURN.—*L'Astronomie* for December contains the results of some observations of Saturn made by M. J. Camus, with the Mailhat equatorial of 0·19 m. aperture, at the French Astronomical Society's observatory, on November 7. M. Camus used a power of 230, and he reports that, in front of the planet, the exterior edge of the crape ring showed marked irregularities appearing in profile as grey patches on the yellowish background of the globe. He was also able to recognise the various tints of the same ring.

IMPROVEMENTS IN MICROSCOPES.

SOME time ago (NATURE, December 14, 1911) we referred to several improvements which Messrs. Beck had introduced into their microscopes, and we noted especially the "handle" model as one in which all risk of damage is avoided to the working parts and adjustments when the instrument is moved. Messrs. Beck now inform us that they have revised the make of their well-known "London microscope" on the handle model. In addition to this, the base and pillar are so designed that although the Continental model has been retained, the position of the centre of the inclining joint has been so placed as to give greater stability when the instrument is in a horizontal position, whilst not interfering with its vertical rigidity, and the size of the base has been increased to that of their large models to insure perfect steadiness under all conditions. The stage is square and specially large, measuring 4 in. in each direction. The coarse adjustment is by a spiral rack and pinion, so accurately fitted that even comparatively high powers can be focussed thereby. The fine adjustment is of the lever type. The adjustment is obtained by a fine micrometer screw actuating a supplementary pointed rod which impinges upon a hardened steel block working upon the lever. The body tube is 140 mm. long, with a graduated draw tube, in a carefully packed fitting, which extends to a length of 200 mm.

We have received a catalogue of microscopes from Messrs. W. Watson and Sons, 313 High Holborn, W.C., in which the well-known instruments manufactured by this firm are fully described. Their microscopes are British, both in design and construction, with the result that such points as a tripod foot to ensure rigidity in any position, and sprung fittings with adjusting screws to compensate for wear and tear, are insisted on. On the optical side, perhaps no firm has devoted more attention than Messrs. Watson to the substage condenser. In this connection it is noteworthy that they are now supplying an aplanatised Abbe illuminator, which has an aplanatic cone of 0·65 N.A., that is, 0·15 N.A. in excess of the ordinary type, its total N.A. being 1·20. At the price of 17*s*. 6*d*. such an appliance is obtainable by all microscopists, and will substantially increase the utility of any optical combination. It is interesting to see that such an improvement in substage illuminators is called for; at least it is reasonable to infer that such a demand has arisen. If it indicates that the average microscopist is at last awaking to the fact that in this direction he has the power greatly to increase the possibilities of his instrument, even if it is of a simple form, then there is much hope in the future for microscopy.

There is another matter of interest referred to in the catalogue. Messrs. Watson are now providing, under the designation *1/12 in., an objective which is really a 1/14 in. They state that many of the 1/12 in. lenses produced by other makers have really the magnification of a 1/14 in., so they determined to supply objectives of similar power. Tested with a Reichert 1/12 and a Leitz 1/16, the magnification of the new lens is half-way between the two. Its N.A. 1·30 and its wonderful definition enable it to resolve difficult test objects. The dots of *Surirella gemma*, for instance, are easily seen with oblique illumination, and the definition is good enough to allow them to be seen, as dots, under a magnification of more than 3000. The colour correction leaves little to be desired, Carpenter's deal test has been applied, but no more than a very feeble trace of colour has been seen in any of the rings. This lens will be a valuable addition to a battery of objectives, and when its actual magnification is taken into account accurate statements of the actual power used can be made.

PRIZE AWARDS OF THE PARIS ACADEMY OF SCIENCES.

THE president of the Paris Academy of Sciences has announced the prizes awarded for the year 1912 as follows:—

Geometry.—Grand prize of the mathematical sciences divided between Pierre Boutroux (3000 francs), Jean Chazy (2000 francs), and René Garnier (2000 francs); the Francœur prize to Émile Lemoine, for the whole of his mathematical works; the Poncelet prize to Edmond Maillet.

Mechanics.—The Montyon prize to Ad. Doutre, for his inventions in connection with the stability of aëroplanes; the Fourneyron prize between G. Eiffel (1000 francs), for his experiments on the resistance of the air, and Armand de Gramont (700 francs), for his books on aërodynamics; the Boileau prize to A. Lafay, for his experimental studies on various problems concerning the action of the wind on solid bodies.

Navigation.—The extraordinary prize for the Navy between M. Le Page (2000 francs), Captain Ronarch (2000 francs), and M. Marbec (2000 francs); the Plumey prize between Victor Garnier (2000 francs), for his invention of a periscope for use in submarine navigation, and Henri Fabre (2000 francs), for his studies on the hydroaëroplane.

Astronomy.—The Lalande prize between H. Kobold and C. W. Wirtz, for their work on the determination of the motion of nebulæ; the Valz prize to A. Schaumasse, for his observations on comets; the Janssen medal (astronomy) to M. Perot, for the application of interference methods to the study of the solar spectrum; the Pierre Guzman prize was not awarded.

Geography.—The Tchihatchef prize to the Duke of the Abruzzi, for the results obtained in his expedition to the Himalayas; the Binoux prize to M. Fichot, for his geodesic researches; the Delalande-Guérineau prize to Captain Tilho, for his geographical work in Central Africa; the Gay prize was not awarded, but Lieut.-Col. Delauney receives an honourable mention.

Physics.—The Hébert prize to M. Houllevigue, for his researches in magnetism and thermoelectricity; the Hughes prizes to Arnaud de Gramont, for his spectroscopic work; the La Caze prize to Marcel Brillouin, for the whole of his researches in physics.

Chemistry.—The Jecker prize to M. Bourquelot, for his work on the chemistry of plants and plant ferments; the Montyon prize (unhealthy trades) to Paul Adam, for his work on the reduction of nuisance in the manufacture of superphosphate and his improvements in the storage of petrol and other dangerously inflammable liquids; the Cahours prize between Mme. Ramart-Lucas, Paul Clausmann, and M. Ostwald; the La Caze prize (chemistry) to M. Urbain, for his researches on the rare earths.

Mineralogy and Geology.—The Victor Paulin prize to Henri Arsandaux, for his chemical and petrographical work on silicate rocks.

Botany.—The Desmazières prize to Élie and Emile Marchal, for their work on mosses; the Montagne prize between Mme. Paul Lemoine (1000 francs) and H. Collin (500 francs); the de Coïncy prize to Camille Servettaz, for his monograph on the Eleagnaceæ.

Anatomy and Zoology.—The Da Gama Machado prize to J. Duesberg, for work relating to spermatogenesis of mammals; the Thore prize to Antoine Grouvelle, for his work on the Coleoptera; the Savigny prize to Louis German, for his researches on the malacological fauna of tropical Africa.

Medicine and Surgery.—Montyon prizes (2500 francs each) to V. Pachon, for his memoirs relating to the measurement of arterial pressure in man, Charles Nicolle, for his work on exanthematic typhoid, and O. Josué, for his researches on arterio-sclerosis; mentions (1500 francs each) are accorded to H. Carré, M. Mathis and M. Léger, and Étienne Ginestous; citations are accorded to Jean Troisier, Henri Claude and Stephen Chauvet, Albert Sézary, A. Magitot, Louis Renon, Noël Fiessinger, Georges Schreiber; the Barbier prize to Eugène Léger, for his pharmacological researches; the Breant prize was not awarded, but the arrears of interest were divided between C. J. Finlay (2500 francs) and A. Agramonte (2500 francs), for their work on the relation of mosquitoes to the propagation of yellow fever; the Godard prize to Jacques Parisot, for his work on the functions of the kidney and the suprarenal capsules; the Baron Larrey prize to Dr. Troussaint, for his memoir on the direction of the sanitary service in war, very honourable mentions being accorded to Ch. Teissier, M. Talon, R. Pigache and M. Worms, A. Conor; the Bellion prize to Mme. Banda-Legrain, for her work against alcoholism, J. Cavaillé receiving an honourable mention; the Mège prize is not awarded, the arrears of interest being given to Mme. Long-Landry, for her researches on Little's disease.

Physiology.—A Montyon prize (experimental physiology) to Paul Portier, for his studies on the digestive zymases, very honourable mentions being accorded to Max Kollmann, Théodore Rosset, and Jules Glover; the Philipeaux prize divided between E. F. Terroine and Marcel Lisbonne; the La Caze prize (physiology) to E. Wertheimer, for the whole of his work in physiology; the Martin-Damourette prize to Maurice Arthus, for his researches on the physiology of snake poisons; the Lallemand prize between Gabriel Petit and Léon Marchand, for their memoir on the comparative pathology of the nervous system, and Giuseppe Sterzi, for his work on the nervous system of the vertebrates; the Pourat prize to F. Maignon, for his experiments on the function of albumen as a food.

Statistics.—A Montyon prize (statistics) between Henri Auterbe (800 francs), Louis de Goy (600 francs), M. Janselme and M. Barré (300 francs), and Broquin Lacombe (300 francs).

History of the Sciences.—The Binoux prize to J. L. Heiberg, for his works on the history of mathematics; an additional prize (1000 francs) to Marcel Landrieux, for his book on the life and work of Lamarck.

General Prizes.—The Arago medal to Prince Roland Bonaparte; Berthelot medals to M. Bourquelot, Paul Adam, M. Clausmann, M. Ostwald, and Mme. Ramart-Lucas; the Gegner prize (400 francs) to J. H. Fabre; the Lannelongue prize between Mme. Cusco and Mme. Rück; the Gustave Roux prize to Armand Billard; the Trémont prize to Charles Frémont; the Wilde prize to M. Ferrié, for his work in the development of wireless telegraphy; the Lonchampt prize between M. Grimbert (2000 francs), M. Bagros (1000 francs), and Jules Wolff (1000 francs); the Saintour prize to Maurice Langeron (with 2000 francs), and a mention (with 1000 francs) to Will Darvillé; the Bordon prize is not awarded, but R. Robinson receives an encouragement (2000 francs); the Houllevigue prize between Henri Lebesgue (3000 francs) and M.

Taveau (2000 francs); the Caméré prize to M. Gisclard; the Jerome Ponti prize to Georges Rouy, for his researches in systematic botany; the Leconte prize between Charles Tellier (8000 francs) and M. Forest (12,000 francs); the prize founded by Mme. la Marquise de Laplace to Jules Adolphe Menj; the prize founded by M. Félix Rivot between J. A. Menj, J. F. G. Daval, R. G. R. Mabilleau, and R. E. Bollack.

THE TIN MINES OF NEW SOUTH WALES.[1]

THE more rapid growth of the demand for tin than of the supply, and the disappointing failure of aluminium to replace tin for many purposes for which it was hoped to prove an efficient substitute, have led to the more careful study of the tin fields of the world and to an increase in the tin production by about a third in the first decade of this century. Mr. J. E. Carne has added a monograph on the tin mines of New South Wales to the series of valuable monographs with which he has enriched the economic geology of Australia.

The monograph is careful and exhaustive, and shows the author's combined caution and insight. It consists mostly of detailed descriptions of the tin mines and mining fields, and the economic problems naturally receive greater attention than the theoretical. There is, however, an interesting discussion of the genesis of tin ores, and the account of the mines is often enriched with suggestions of general interest. Economic questions are especially important in connection with a metal which is subject to such violent fluctuations in value, for the price of tin on the London market has varied since 1905 between 120*l.* and its present price of 230*l.* per ton. The association of tin with pegmatite veins has led to its being often claimed as one of the metals most likely to be of direct igneous origin; but Mr. Carne rejects the view that the tin in some granites was a primary constituent of the granite, and has been collected into veins as a direct differentiation product. He lays stress on the evidence which points to the deposition of the tin after the complete consolidation of the granite.

The New South Wales tin deposits are, however, not of the kind for which there is most to be said for the igneous theory. Mr. Carne gives a list of seventy-seven tin veins in New South Wales, and in sixty-nine of these the tin is associated with quartz, in twenty-nine with chlorite, in twenty with felspar, and in only three with tourmaline. The rarity of the association with tourmaline suggests that tin in New South Wales is not a pneumatolytic product.

The first record of tin in Australia which Mr. Carne accepts as authentic was in 1824. Actual tin-mining in New South Wales only began in 1872. Since 1875 the largest field—Emmaville—has yielded about 52,000 tons, and the Tingha field has yielded slightly less (45,500 tons). The tin mines in New South Wales include both alluvial deposits and lodes. The lodes belong to a type in which the distribution of the tin is sporadic and the patches of ore become smaller and poorer in depth. The deepest tin mine in Australia is the Vulcan Mine in North Queensland, which has already attained the depth of 1400 ft. The deepest in New South Wales is only 360 ft., and Mr. Carne's account of the lodes renders this fact not surprising.

J. W. G.

[1] "The Tin-mining Industry and the Distribution of Tin Ores in New South Wales." By J. E. Carne. (New South Wales Department of Mines, Geological Survey, Mineral Resources No. 14.) Pp. 378+xxviii plates+8 figs.+14 maps and sections+iii maps in portfolio. (Sydney, 1911.)

OSMOTIC PRESSURE AND THE THEORY OF SOLUTIONS.

ATTENTION may be directed to a paper by Prof. A. Findlay on osmotic pressure and the theory of solutions, which has recently been published in *Scientia*. It has sometimes been suggested that the problems of osmotic pressure were solved once for all by van't Hoff's discovery that the gas equation $PV = RT$ could be applied to solutions by substituting "osmotic pressure" for "gas pressure." But the recent exact measurements of the Earl of Berkeley and Mr. Hartley in England and of Morse and his colleagues in America have shown clearly that this simple equation is so restricted that it cannot in practice be applied with any approach to accuracy in the case of any of those solutions of which the osmotic pressures have been exactly measured.

As Prof. Findlay points out, the first limitation to the equation $PV = RT$, when applied to solutions, is that the method used in deducing it only holds good for very dilute solutions. For stronger solutions the equation $P = \frac{RT}{V} = \frac{RT}{V_o}x$ becomes

$$P = \frac{RT}{V_0}\left\{-\log_e(1-x)\right\} = \frac{RT}{V}\left\{x + \tfrac{1}{2}x^2 + \tfrac{1}{3}x^3, \&c.\right\}$$

where V_0 is the molecular volume of the solute and x is the molar ratio, *i.e.* the ratio of the number of molecules of solute to the total number of molecules present.

This equation assumes that there is no formation of complex molecules, no change of energy or volume on mixing the liquid solvent and solute, and that the solution is incompressible. G. N. Lewis has shown that it holds good in a marvellous way when applied to vapour pressure measurements in mixtures of propylene bromide and ethylene bromide at 85°. But even this equation fails to represent with any approach to accuracy the measured osmotic pressures of cane-sugar solutions. Better results are obtained by assuming the formation of a hydrate of the sugar, but it is abundantly clear that van't Hoff's equation is only the beginning and not the end of the quantitative study of osmotic pressure, and that direct measurements of this property are still of the highest importance in studying the theory of solutions.

ENGINEERING AT THE BRITISH ASSOCIATION.

A GLANCE at the proceedings of the Mechanical Science Section shows that a wide range of subjects was considered by the members, and, indeed, much planning was required to group the papers in such a way that all could be read and adequately discussed, and every moment of the available time was fully occupied in carrying out the longest programme of recent years.

In the course of his presidential address on the Thursday morning, Prof. Barr discussed the relation of the engineer to the public, both from a utilitarian and an æsthetic point of view, and by aid of many illustrations of modern engineering achievements he again and again enforced his main argument that the maintenance of a high ideal in all engineering work was necessary to obtain the highest good for the greatest number.

Such illustrations as the attainment of dustless roads, smokeless factories, ships, and locomotives, and the abandonment of all sham decoration of engineering structures gave point to an address which was free from technicalities and permeated by a dry, literary humour of its own.

The address was followed by an important report, the fifth of the Gaseous Explosions Committee, which dealt chiefly with the radiation effects and the turbulent motion of the gas charge in the cylinders of internal combustion engines. In this account of a large amount of new work carried out by different members, the committee shows that turbulence plays a most important part in determining the time of ignition of the charge in high-speed engines, such as are now used for motor-cars and aeroplanes, while it also has a large effect on heat loss, although at very high explosion temperatures the radiation effect is of chief importance.

In connection with this paper Prof. Harold Dixon confirmed some of the results of the committee's work in his account of the experiments on coal dust explosions at Eskmeals conducted for the Home Office.

Prof. Thornton also described his experiments on the igniton of gaseous mixtures by momentary arcs, and indicated the safe limits for operating electrical machinery in coal mines containing inflammable gases.

An important discussion with Section A on wireless telegraphy commenced the proceedings on the Friday morning. This joint meeting afforded an animated discussion in which a number of speakers representing both sections took part. A summary of the chief matters of interest has already appeared in these columns (December 12, p. 421), and it only remains to mention that this meeting was the most successful joint gathering of these sections in recent years.

A paper immediately following, by Dr. Eccles and Mr. A. J. Makower, dealt with the production of electrical oscillations with spark-gaps immersed in running liquids. Although it appears that the efficiencies are about the same as that of an ordinary spark-gap in air, yet the former have the advantage of being practically noiseless, a matter of some importance in large-powered wireless stations.

The impedance of telephone receivers was also discussed in a paper by Profs. Kennelly and Pierce, and the effect of the motion of the diaphragm was analysed in some detail.

Another electrical paper of great interest was contributed by Prof. J. T. Morris, who described a method of measuring wind velocities by the aid of a small bare wire Wheatstone bridge having arms of manganin and platinum. The cooling effect of a current of air has no influence on the resistance of the manganin, but it lowers the resistance of the platinum, and an increased current is therefore required to effect a balance. This change of current is a measure of the velocity of flow of the air, as the author demonstrated by lecture experiments.

A discussion on the gas turbine, at the commencement of the Monday meeting, was opened by Dr. Dugald Clerk, who described the attempts which have been made in recent years to construct a successful gas turbine. In particular, the performance of the large turbine recently constructed by Herr Hans Hobzwarth was analysed in some detail. Unfortunately, Herr Hobzwarth was, at the last moment, prevented from attending the discussion, and the details of his latest improvements were not available.

An interesting group of papers dealing with motor-car and aviation problems was headed by a contribution from Sir John H. A. Macdonald, K.C.B., F.R.S., on "The Road Problem," in which he described the road-making methods of Macadam and Telford, and the modern attempts to obtain a dustless and practically indestructible road suitable for motor vehicles. Various interesting experiments on the acceleration and tractive power of motor-cars were described by Mr. Wimperis, who, in the absence of the author, Prof. Chatley, also gave a summary of a paper on the control of aeroplanes. The results of experiments at the East London College on the distribution of pressure on inclined aerocurves were also described by Mr. A. P. Thurston.

A considerable portion of the sitting on the Tuesday was devoted to naval problems, and the first paper was a notable contribution on the suction between passing vessels by Prof. Gibson, of University College, Dundee, and Mr. Thompson, the engineer of the Dundee Harbour Trust. Numerous experiments were made with a fair-sized steam yacht, and a 30-foot motor-boat running on parallel courses at speeds of about six knots, and these showed that suction was considerable, and rapid in action at lateral distances of less than 100 feet.

Prof. Henderson discussed problems in propulsion by the aid of energy systems moving with the propelled body, and Mr. Mavor described some large new vessels fitted with his system of electrical transmission, and showed the advances made since his paper of last year.

Mr. Axel Welin also described his system of lifeboat lowering and raising gear, which is now being fitted to numerous passenger vessels.

Papers relating to the testing of materials were taken on the concluding morning.

Prof. Coker described some optical determinations of the distribution of stress in plate and coiled springs, and also the results of stress determinations by thermo-electric methods. These latter have an advantage in that they depend on the sum of the principal stresses at a point, while optical measurements determine the difference, and a combination of both methods was advocated in certain cases.

Mr. Haigh described an ingenious electro-magnetic machine for obtaining repetitions of stress at frequencies up to 120 per second, and Mr. Larard showed some very fine kinematograph films of the fracture of torsion specimens.

Papers by Prof. Petavel and Dr. Lander were also read during the meeting, describing experiments on heat transmission, in which attention was directed to the large convection losses of steam-pipe coverings.

Mr. R. S. Whipple described a Féry bomb calorimeter in which the rise of temperature due to combustion is measured by thermo-couples, and the heating effect is absorbed by the metal, no water being employed.

Dr. Gray and Mr. Burnside gave an interesting demonstration of their motor gyroscopes, and Prof. Wilson gave an account of some exposure tests of aluminium alloys, while Dr. Wall discussed the question of hysteresis loss in iron due to pulsating and rotating magnetic fields.

Mr. T. Reid described a new form of rescue apparatus for coal mines, and Dr. Owens contributed a paper on the weathering of Portland stone.

The section was well attended throughout, and the discussions were well sustained. During the proceedings the section heartily congratulated Sir William White, K.C.B., F.R.S., a past-president of the section, on his election to the presidency of the Association for the Birmingham meeting next year. It is interesting to recall that in the last twenty-five years two other distinguished engineers, Sir Frederick Bramwal and Sir Douglas Galton, have filled the presidential chair.

E. G. C.

LORD LISTER.[1]

Introductory Remarks.

It is said that the Egyptian kings, after death, had to undergo a trial before they were embalmed. Our great men appear to be similarly arraigned, as their character and attainments are brought to judgment by the lesser ones of earth, who bear testimony concerning them, weighing them in their own balance, each to his entire satisfaction.

The reputation of the smaller great men may be affected by this judgment. The reputation of the truly great lies beyond the reach of blame or praise, and lives on in history after all those who have weighed them have been forgotten. Such was Lister.

Unlike the Egyptian kings, however, Lister was tried during life. His struggle with disease and with the mind of his fellow-men, though long and severe, was ultimately successful, and the great good achieved by the adoption of his methods was universally acknowledged. Whilst yet in the autumn of his life he was able to look on at the spread of the antiseptic system over ever-widening areas, and to rest in the consciousness that he had accomplished a great work for the good of mankind.

It would be out of place here to lay before you in their order the honours and titles showered upon Lister in the latter period of his life, or to refer to the impressive ceremony on the occasion of his funeral in the fane of the immortals—Westminster Abbey—save to remind you that, though the Abbey was open to receive his remains, the true man was shown in him when he directed that his body should be laid where his dust would mingle with the ashes of one he loved, and who had been his constant companion and helpmate during the most active portion of his life.

Lister's Early Days.

His Father, Joseph Jackson Lister.

Lister was blessed in his earlier days by excellent environment, well suited to one who was about to follow a scientific career.

His father, Joseph Jackson Lister, was a man of outstanding scientific merit. He left school at fourteen years of age, to assist his parent at the wine trade, in London, and though for many years closely tied down to business, he yet contrived, by early rising and otherwise, to gain free hours in which to supplement the education received at school, which, though sound, was insufficient for his needs. He was thus, in many respects, a self-taught man. He possessed extreme accuracy of thought, and was a most methodical worker, skilful with brush and pencil. As a microscopist he was the first to solve the problem of the achromatic lens, whilst many observations on zoophytes and ascidians were made by him—a paper on the former appearing in the Philosophical Transactions.

Here, then, was a man of grit, who left school at fourteen years of age to enter business in London, but who, by dint of his own exertion, found means to extend his scanty education, devoting what time he could to scientific pursuits with accuracy of thought and methodical work. Had it been in one's power to choose a father for Lister, one could not have chosen a man better suited to the purpose.

His Teachers and their Influence.

The influence of Sharpey upon young Lister was great. At University College he was guided by Sharpey to undertake important researches, which were continued by Lister after he had left London. Papers were written by him upon numerous physiological and histological subjects—such as the contractile tissue of the iris, an inquiry regarding the parts of the nervous system which regulate the contractions of the arteries, the cutaneous pigmentary system of the frog, the coagulation of the blood, the early stages of inflammation, &c. There also Graham aided him in the study of chemistry, and furnished his mind with a sound knowledge of its principles. In Edinburgh he studied under Syme, and became a great admirer of Syme's intellect and judgment, as well as of his skill as an operator. This intimacy ripened and lasted throughout the remainder of Syme's life.

All these men were the best he could have been educated under and associated with. The knowledge and experience gained from them admirably equipped him for the life of research which he was about to enter.

It is obviously impossible here to deal with all the periods of Lister's life, and therefore it has been deemed expedient to select one of these, and that the most vigorous of his career, when he evolved the theory of antiseptics, and when he had to defend his thesis.

Pre-Antiseptic Days.

In Lister's early surgical days in the Glasgow Royal Infirmary he encountered the same phenomena, which prevented the healing of wounds, in all hospitals throughout the world. Suppuration in wounds was the rule, and very profuse it generally was. Dressing of the wounds had to be done daily, and sometimes several times a day.

The handling of highly-inflamed wounds was a source of pain, and the dressing was anticipated by the patients with an apprehension akin to terror, especially as the exhausting process, with its accompanying high fever, reduced the resisting powers of the individual to a low ebb. The suppurative process invaded the deeper tissues, affecting the blood-vessels, and produced septic thrombosis, from which septic emboli were carried to distant parts. The effect of the dissemination of the septic material was soon shown in the high temperature, the violent rigours, the profuse sweats, the sweetish, sickening odour from the breath, the yellow cachexia, emaciation, and final delirium which all too frequently ended in death. Sometimes every patient in a ward who had a serious operation performed upon him would be swept away. The wards would then be emptied, lime-washed, well ventilated, and reopened, soon to be the scene of further pyæmic ravages.

All this was most depressing for the attendants, and many of the young student dressers had at times to retire to the restoring influences of the open air, and there debate within themselves whether it were physically possible for them to continue their work in the midst of such scenes of suffering.

Surgeons and patients alike dreaded operations, owing to their terrible results, and only operations of dire necessity were permitted to be performed. Severe compound fractures were treated by amputation of the limbs, as to attempt to save them was to court disaster. Consequently amputations in those days were common. It is impossible for students of the present day adequately to realise the conditions which previously existed.

Inflammation supposed to be necessary to Wound Healing.

Surgeons were ever at work, attempting to discover the cause of this excessive inflammation, and many were the theses and volumes written on the subject.

[1] From a discourse delivered at the Royal Institution on June 7, 1912, by Sir William Macewen, F.R.S.

It was fully recognised that, if one could discover the cause of this excessive inflammation, it would be the first step toward eradicating the serious conditions attending wound healing. The minds of men, however, were obscured by an initial error of fundamental importance, which warped their vision, and for which the doctrine inculcated at the time was responsible. The error lay in the belief that, with the exception of healing by what was known as primary union, inflammation was necessary for wound healing, and that in the process of healing the phenomena of inflammation were always present.

Wound healing was treated in the text-books under the heading of inflammation. So that, instead of inflammation being regarded, *ab initio,* as a noxious process, it was looked upon as a necessary and beneficent one. It was only when it became excessive that it was regarded as baneful, and efforts were made to lessen it.

The trend of inquiry was therefore directed toward the elucidation of the phenomena produced by inflammation on the tissues, instead of endeavouring to discover the cause of inflammation and how it could be prevented.

Saviotti and Lister on the Nerve Control on the Blood-vessels in the Early Stages of Inflammation.

Much time was devoted by many observers to the elucidation of the effect of reflex action upon the blood-vessels, in the early stage of inflammation. The investigations of Saviotti[2] and Lister proved that reflex action, to which alone active hyperæmia had been previously attributed, was not the only factor in the production of increased local blood supply. From observation on the cutaneous pigmentary cells of the frog, it was evident that they were controlled by reflex action, as exhibited when the pigment in them contracted to the centre of the cell, under the influence of a beam of light, passing through the eye of the animal. It was also seen that limited areas could be taken out of the control of this general reflex action, by the application of certain irritants applied locally.

In order to account for this latter phenomenon, it was deduced that peripheral nerve ganglia must exist, having control of limited areas, and that when these ganglia were paralysed, they would no longer transmit the general nerve impulses.

Granting this conclusion, it was further deduced that a similar local nerve control might regulate the smaller blood-vessels under topical irritation of the parts and in the earlier stages of inflammation. If these ganglia were paralysed, the arteries would dilate, as is seen in active hyperæmia.

These communications were interesting and important, yet, though highly appreciated by all who valued science for itself and admired it for the truth it aimed at, they did not directly appeal to those who look lightly upon investigations the results of which are not immediately productive of direct and tangible benefits.

Microbes Discovered to be the Cause of Putrefaction and Fermentation (Cagniard-Latour and Schwann).

While darkness still brooded over the realm of medicine and surgery, notwithstanding endeavours to reach the light, investigations had been conducted in quite other fields, which were not only important in themselves, but were destined to lead to the revelation of multitudes of hitherto invisible organisms, everywhere existing, and playing a very potent part in the economy of the world.

More than thirty years previously, 1835–37, Cagniard-Latour in papers to the French Academy[3] recognised that alcoholic fermentation was due to the presence of a living organism. He found that grape-juice contained numerous globular bodies which he considered to be of vegetable nature, and which reproduced themselves by budding. These were always present when fermentation occurred, and in their absence fermentation did not take place.

In the following year, Schwann, of Berlin,[4] published the results of an investigation into the causes of putrefaction, in the course of which he also independently discovered the yeast plant.

What was of equal importance, he demonstrated that a putrescible fluid, such as a decoction of meat, could be freely and indefinitely exposed to the action of pure air—air free from dust and organisms—without putrefaction ensuing in it.

Those views of Schwann that putrefaction is due to the action of living organisms, and those of Cagniard-Latour showing that fermentation is caused by the yeast plant, did not, for more than thirty years, yield the fruit which, viewed from present knowledge, might have been expected from them.

Cagniard-Latour and Schwann's Observations confirmed by Pasteur, 1858.

Pasteur, when in the University of Lille, had abundant opportunity of studying alcoholic fermentation, as alcohol was the staple article of manufacture in that town. He became thoroughly convinced of the correctness of the observations and deductions previously made by Schwann and by Cagniard-Latour. He verified and extended those observations showing that fermentation was due to micro-organisms, and confirmed the observations of Schwann that pure air had no effect in producing putrefaction.

An Organism found to be the Cause of a Disease by Davaine, 1850.

In 1858 Pasteur reasoned from analogy that the relation of micro-organisms to disease was highly probable, and that the changes taking place in the secretion of a wound were probably due to a somewhat similar process to that of fermentation. The probability of micro-organisms being the cause of disease was greatly increased by a momentous discovery from a totally different quarter, an organism having been constantly found invading the tissues and blood-vessels of animals which had died of splenic fever. This was the *Bacillus anthracis,* discovered by two observers, Davaine[5] and Rayer in 1850, though it was ten years later before the complete identification of the relationship of this germ to the disease was definitely established.

Chronologically this was the first pathogenic bacillus discovered.

Other Theories of Fermentation.

Those observations and conclusions of Schwann, Cagniard-Latour, Pasteur, and Davaine were not generally known, and, where known, were not generally accepted, other theories being still in the field.

Besides the chemical theory of fermentation and putrefaction, the believers in heterogeneous and spontaneous generation were still many. Pouchet,[6] in 1859, made a systematised attempt to prove the possibility of spontaneous generation, and even after the antiseptic theory had been formulated, spontaneous

[2] "Virchow Archiv," vol. i.

[3] *Annales de Chimie et de Physique,* t. lxviii., 2nd series, p. 206, 1838; *Comptes rendus,* t. iv., p. 905, 1837.

[4] *Poggendorff Annalen,* xli., p. 184, 1837.

[5] Davaine, "Recherches expérimentales sur la Maladie Charbonneuse," par H. Toussaint. (Paris: Asselin and Co.)

[6] Pouchet, "Heterogénie ou Traité de la Géneration spontanée base sur des nouvelles expériences." (Paris, 1859.)

generation was still advanced by Bastian[7] and other observers, who tried to demonstrate that vital force and living matter may arise *de novo* under the action of ordinary physical forces.

Tyndall, Huxley, and Ray Lankester against Spontaneous Generation.

Such writings had the effect of confusing the issue and diverting men's minds from the truth, and it was in no small measure due to the powerful help of Tyndall, Huxley, and Ray Lankester that the error was conclusively refuted.

Dr. E. Ray Lankester (NATURE, January 30, 1870) stated that he had performed numerous experiments with turnip solution, made under the conditions given in Dr. Bastian's book. No life was developed, a result contrary to that obtained by Bastian.

Prof. Huxley (NATURE, October 13, 1871) stated that he had seen Dr. Bastian's experiments and preparations, and expressed his belief that the organisms which Bastian got out of his tubes were exactly those which he put into them.

Tyndall, the illustrious predecessor of Sir James Dewar at the Royal Institution, submitted the question to fresh investigations. He had gone over the ground on which Bastian took his stand and was able to expose many of the errors by which experimenters were misled. One very beautiful and convincing experiment was introduced by Tyndall. He observed the fact that in a box the sides of which were coated with glycerine, all the particles of dust floating in the inside air fell and adhered to the glycerine in the course of a few days. The air is then *optically* pure. A transmitted ray of light tells the moment when this purity is obtained. Tyndall proved that to an eye rendered sensitive by remaining in darkness for a few minutes, the course of the ray is visible only so long as there are floating particles of dust capable of reflecting or diffusing light. On the other hand, the course of the ray becomes invisible to the eye as soon as the air has deposited all its solid particles.

When this deposition has occurred, any organic infusion may be introduced into the box and kept there without undergoing the least putrefactive or fermentive change, and without producing bacteria.

Lister Promulgates and Introduces the Practice of the Antiseptic Treatment of Wounds.

While professor of surgery in Glasgow, Lister was constantly speculating on the cause of inflammation and the cause of putrefaction in wounds, and during a discussion with friends, it was suggested to him that Pasteur's papers on fermentation might be of use in elucidating what seemed to be somewhat kindred processes. These papers of Pasteur came as a revelation to Lister, especially as he had not been cognisant of the observations made about thirty years previously by Schultze (1836), Schwann (1837), and Cagniard-Latour (1838), which had really laid the foundation of the germ theory and modern bacteriology.

The perusal of Pasteur's work threw a flood of light on the subject of decomposition in wounds, and Lister at once accepted the theory, and began a search for a something which would prevent the entrance of living organisms into wounds, believing that if such were found the healing of a wound would proceed "just as if it were subcutaneous."

About this time creosote—the active agent of which was carbolic acid—was used for disinfecting sewage, and Lister secured a sample of carbolic acid from Dr. Anderson, professor of chemistry in Glasgow University. He tried it in August, 1865, with results which justified his hypothesis.

[7] Bastian, "The Beginnings of Life," 1872; "The Evolution and Origin of Life."

In the wards of the Glasgow Royal Infirmary, which, previously, in common with other hospitals, had been the home of septic diseases, with their terrible issues, the introduction of the antiseptic treatment by Lister acted like the magician's wand, dispelling the horrors which previously accompanied wound-healing and creating an atmosphere of sweetness and health.

Difficulties in Accepting Antiseptic Theory and Practice.

The new treatment and the theory on which it was founded were received at first—save by a few faithful pupils—with scepticism and coldness, and later on with open hostility.

Germs in purulent wound secretions were not then demonstrated, and Lister was boldly called upon to show those organisms in such secretion before founding a theory and practice upon the assumption of their presence. This desirable demonstration was not obtained until later (1880–81), when Billroth and Ogston demonstrated the presence of organisms in pus taken from acute abscesses. Yet the deduction arrived at by Lister at that time, from the experiments of many able and trustworthy men of science, was not only permissible, but was the only one to which the data then available inevitably pointed.

Subsequent investigations with which all are now conversant abundantly proved the correctness of the conclusion.

The usual fate meted out to innovators or disturbers of settled doctrines was shared by Lister. He and his theory were virulently assailed both from within the hospital and from without. Some colleagues, some governors, and a host of freelances all joined in the fray, the most ignorant being ever the loudest. He was despitefully used, and had to bear the derision and cackle of fools. A scoffer has not necessarily a high standard of intelligence, and at best he does but devil's work. Fortunately such ephemera, troublesome and annoying as they are, die before the light.

Germany readily accepts Antiseptic Teaching.

Lister's teaching in this country was at first of no avail. It fell upon ears unprepared to receive it. Except by his own students in Scotland and a sprinkling of them in England, the antiseptic treatment passed unheeded over Britain, yea, even over the land of Pasteur it passed to other nations, especially to that country where the scientific education of its people, their earnestness of purpose, thoroughness of method, and their desire to see under the surface enable them to appraise quickly any theory and practice having a scientific basis.

Another reason for the rapid spread of antiseptics among the surgeons of northern Europe was that they bestirred themselves "to go and see" the practice first-hand. Thereafter they returned to their homes with a precise knowledge and a truer conception of the theory and practice than they otherwise could have had.

The influence of Danish and German testimony, corroborative of the value of the antiseptic treatment, made itself felt, and did much to render its adoption universal.

Pyogenic Organisms Discovered, 1880; Organisms the Cause of Disease.

The discovery of pyogenic organisms as the cause of suppuration in wounds was of great importance, as it demonstrated the correctness of Lister's theory and gave a tangible basis for the practice. It placed both the ætiology of suppuration and its treatment upon a scientific basis. Empiricism was in great measure overthrown, and henceforward a rational ætiology for disease and its treatment was sought. Microbiology, then in its infancy, received a great impulse, and fresh fields were opened from which an ever-increasing harvest has been reaped. From the burning plains and pestilential swamps of the tropics, to our own slums, with their three great D's—dirt, damp, and darkness, which we fondly harbour in our midst—disease after disease has been traced to its micro-organismal cause. Those diseases which remain will doubtless yield their secret to steady investigation, and would do so all the more readily if submitted to a properly constructed investigation department under scientific control.

Tuberculosis, which for centuries was regarded as an hereditary disease, was shown to be germ-borne, common to man and to the lower animals, and to be intercommunicable between them. Cancer and sarcoma and the varieties included under these terms are doubtless also germ diseases, the germs of which are probably to be found near our everyday life, if our eyes were open to perceive them. The need of a scientific experimental investigation department under scientific control is all the more apparent as the Government has at last ventured to advance measures intended to mitigate one of the communicable diseases —tuberculosis.

Yet what the governing bodies do with the one hand they undo with the other.

For instance, in the old days the light that entered our houses was taxed, and the windows became smaller; to-day the powers that be tax the air contained therein, and for every cubic foot of air enclosed additional charge is made. In order to escape or to lessen this burdensome assessment, many huddle themselves and their families into dwellings of the smallest compass, where they inhale pre-breathed air, with the resultant lowering of vitality, germ-dissemination, disease, and death. Then we appoint commissions to find out the cause of the deterioration of the race!

Every man who is born has an inalienable right to as much fresh air as he is able to consume; but the "powers that be" say, "God may give you that right, but we shall tax you for using it." It is true that they do not as yet tax us for the amount of air we inhale out of doors, possibly because they do not know how to estimate the individual consumption. Yet the governing bodies are full of humanity and have the best intentions. When the ravages of tuberculosis can no longer be hidden, as it stares them in the face, they are moved to grasp at the first thing that appeals to them, and they say to the affected, "Come, let us help you; we shall put you in sanatoria." What happens there? The patient has his birthright restored to him in being able to breathe the fresh air which God has meted out so freely, and for the use of which he was previously taxed.

Would it not be better to begin at the other end?—better to stop producing tuberculosis than merely to alleviate or to cure it once it has developed?

Modifications in Antiseptic Treatment.

Antiseptic treatment underwent many modifications. What was essential in the early days of its introduction became no longer necessary as the advance of knowledge brought clearer conceptions and paved the way for radical changes in the form of treatment. It became apparent that though strong antiseptics introduced into wounds destroyed organisms, they at the same time exercised an irritating influence on the living tissue, lowering its vitality, decreasing its resisting power, and increasing its secretions. To that extent the free use of antiseptics in the interior of wounds was detrimental.

Besides being harmful, they were unnecessary, as healthy living tissue of the interior of the body is free from germs, and pure air is innocuous.

Evolution of Aseptic Treatment.

As microbiology yielded its secrets, the bearing of germs and their products on the phenomena of disease ever became the clearer. The primitive conception of germs acting upon the human body just as they would in a laboratory test-tube was soon dispelled, and the multiplicity of the defensive reactions established by the living tissues for their own protection was recognised. It was seen that the microbic products excited the tissues to anti-bacillary action, and the elements of immunity, as we now understand it, were established.

The anti-bacillary phagocytic action of the living healthy tissue was demonstrated by the beautiful experiments of Metchnikoff, when it was seen that a certain number of organisms, brought into contact with the living tissue, could be destroyed therein by living cells. It also became obvious that the healthy living tissue in the interior of the body was inherently free from germs, and when wounded was capable of healing rapidly, and would do so if its vitality were preserved, and if germs emanating either from the abundant flora of the skin or from elsewhere could be prevented from being brought into contact with it.

This was effected by sterilising the skin and the instruments and all material brought into contact with the wound, without allowing antiseptics to invade the interior of the tissues.

It is upon such lines that aseptic treatment was introduced. Aseptic surgery was a natural evolution of antiseptic surgery—the one paved the way for the other.

The surgery of the present day involves the performance of painless, almost bloodless, operations, the wounds healing, as a rule, under a single dressing of the slightest description. Any material introduced into a wound for the arrest of hæmorrhage, or for bringing the parts together, is of a kind which, after its function has been performed, the living cells are able to remove. When the patient recovers from the effects of the anæsthetic his trouble is over. The film which covers the wound drops off of itself as soon as the phagocytes have completed their work of removing the deep part of the catgut stitches.

The air of cheerfulness in a surgical ward is now pronounced, the difficulty often being to persuade the patients to remain quiet for a time sufficient to allow the internal parts to heal.

Advances consequent to the Introduction of Aseptic Surgery.

The introduction of aseptic surgery and the extension and more correct appreciation of bacteriological knowledge have enabled surgical procedures upon the human body to be greatly extended. The dangers arising from risk of wound infection being averted, many new devices have been practised for reaching the internal organs and for removing therefrom the products of disease.

Regions of the body hitherto considered too dangerous to be operated upon have now been successfully entered, and it soon became apparent that wherever diagnosis showed the presence of a serious pathological lesion, there the surgeon could follow, and where practicable eliminate it.

Since the introduction of asepsis and the consequent acquisition of extended and more definite pathological knowledge, the field of greatest surgical activity has been the abdomen—abdominal surgery, as we now know it, has been created. Tens of thousands—possibly millions—of human lives have been saved in this field alone, and the amount of pain and discomfort alleviated has been enormous.

Surgeons of all countries have contributed to this beneficent result, and have vied one with another in restoring health and comfort to the community, thus adding greatly to the economic prosperity of the nations.

Compound fractures, so fatal in pre-Listerian days, were not only robbed of their fatality, but surgeons became emboldened to make compound fractures for the rectification of malformation of the limbs.

Compound fractures, under the heading of osteotomies, have been performed aseptically in thousands—the bones healing aseptically. A portion of bone which has been fractured and displaced may be removed, placed in aseptic solution, pared, rearranged, and returned to its proper place in the body, where it will live and grow, and become restored to its functional use. Defects in the bone of one person may be made up by grafting on a portion of bone removed from another. A transplanted bone may be divided into little pieces, and a mosaic work of new bone may be placed in another animal to restore defects.

Asepsis, along with better knowledge of the physics of the pleura, has enabled surgeons to penetrate into the lungs and to remove therefrom pathological products, with a gratifying amount of success. Portions of lung have been removed, and several times the whole of one lung has been successfully taken away—the patients still continuing to enjoy life, working for their own living and one, at least, for that of his family.

Aseptic surgery has enabled operations upon the brain to be safely undertaken, and brain surgery has kept pace with the localisation of cerebral function. Its further development rests with the increase of precise data on that subject. Direct experiment on the brains of lower animals furnished excellent data on the localisation of the motor functions, but information as to the localisation of the higher intellectual functions must be gathered by patient clinical observation.

The discerning eye and the discriminating sense guiding the educated finger with its softness and lightness of touch have, under asepsis, carried out many operative procedures on diseased brains, where the tangled skeins of that delicate fabric have been unravelled.

Considering the delicacy of the organ, and the fact that in many instances life has been sapped at the governing centres of energy by the pathological lesions, operations on the brain have been very successful, many of them veritably snatching the patient from the brink.

The consummation of al[illegible]gical activity has been attained by the int[illegible]of aseptic practice, surgery having been re[illegible]eloped since the introduction of Listerian principles and treatment.

Personal Teaching and Demonstration versus *Books.*

It is fashionable nowadays to decry university teachers and professors, many regarding them as an effete remnant of antiquity. It is contended that all that is required is to issue a paper or a book and allow the students to read at their own firesides instead of compelling them to attend lectures and demonstrations in a university.

It is true that formerly the teaching extended only so far as the teacher's voice could carry, but now one can write in one's own laboratory, and, if the message be important, it will be borne to the limits of the civilised world, and thus it is possible to instruct an audience of unlimited size.

There is, however, a difference between teaching by books and *viva voce* teaching and demonstration. Some things may be explained by means of clear writing and may be understood by correct reading, but there are other things difficult of comprehension in detail without the aid of practical demonstration. More especially is this the case when one has not the opportunity of personal contact with the introducer or with one who has seen his practice and followed his methods. No matter how well a statement may be written, impressions are drawn from it which differ according to the preparedness and previous experience of the mind of each individual reader. Personal observation produces a much more vivid impression and generally corrects individual misconstruction.

As professor of surgery in Glasgow, Lister followed the Scottish method, teaching the principles of surgery in the University, and afterwards demonstrating his methods in the wards of the infirmary. His lectures in the University and his observations in the wards were complementary to each other, and gave a groundwork more thorough than could otherwise have been obtained. Those who had been so taught found his methods simple and easy of execution, and were often astonished at seeing others less fortunate falling into serious errors in their attempt to carry out the antiseptic practice after reading Lister's papers alone.

There were many earnest men—professors of Continental universities, amongst others—who were well qualified to read correctly what had been written, yet who, having read, were not satisfied, but straightway desired to be brought into personal contact with the professor, in order that they might hear his teaching from his own lips and see the practice carried out by his own hands.

Prof. Saxtorph, of Copenhagen, was amongst the first of the many distinguished visitors to the Glasgow Royal Infirmary to see Lister's practice and to study his methods. After a few days he remarked that the seeing of the practice persuaded him of its feasibility, and that it then seemed much easier than it did when he had only read Lister's papers. So it was with many others.

Lister as a Scottish and as a London Professor.

Lister's teaching was more rapidly propagated among the students he had in Scotland than among the London students. The position which he occupied as a Scottish professor aided in this, as it was different from that held by him as professor of surgery in a London hospital.

In London in those days, the bulk of students desired, naturally, to take the membership of the College of Surgeons, and most teachers at that time taught to the requirements of the Board of Examination, otherwise their prelections were not specially sought after. In London, Lister was teaching a new doctrine, not yet generally homologated, and his wards were attended by few students compared with the numbers that surrounded him in the Scottish universities. On the other hand, Lister had less time to devote to the teaching of students, as London was more accessible to foreign visitors, and many of his days were devoted to demonstrations for their benefit.

As a Scottish professor, Lister's position offered the greatest advantage for the dissemination of his doctrines. He could teach his own students what he believed to be true, and, if necessary, teach them in advance of the time, as the teaching and the examination were both under his supervision. Hence Glasgow students were the first to become imbued with the spirit and to grasp thoroughly the principles of antiseptics, which they carried into practice. Scottish students thronged his wards and lecture-theatres in the infirmaries, an eager, critical, and ultimately an enthusiastic crowd, bringing inspiration to their teacher, whose principles and practice they afterwards bore to the ends of the earth, even before many examining boards were prepared to accept his teaching.

Lister's Influence on the Scottish Students.

Lister's presence in the Scottish universities was of the utmost value. By him teaching was maintained at a high level; he used the universities to stimulate thought, and therein aided them to perform their highest function. It was an inestimable blessing to a university to have such a man in it, and a priceless privilege to the students—to those of them who could appreciate it—to be allowed to stand silently by and watch the habit of mind and see how the brain worked. He was a man in earnest, and therefore he taught. His teaching was supported by direct appeal to nature. He accumulated data by observation and experiment, from both of which careful deductions were drawn. As a thinker, Lister did good by laying bare the difficulties he encountered in carrying out his projects, and his modes of overcoming these difficulties. In this way he stimulated and propagated the thinking faculties of the student. He showed his methods and thereby paved the way for others to follow.

In Glasgow Lister not only promulgated the theory of antiseptic surgery, but he worked out and thoroughly established its utility in practice, leaving behind him a body of enthusiastic disciples. After spending, as Regius professor of surgery, nine of the most active years of his life, and those fullest of scientific fruition, Lister passed quietly from Glasgow without public recognition of his services, the general body of citizens being unaware that a great scientific achievement had been wrought in their midst. It was long afterwards, when "all the world wondered," that Glasgow became alive to what it had possessed—and lost.

The Students' Appreciation of Lister.

As to the manner in which Lister was viewed by the Glasgow students, the following is an extract from a letter written me by a friend and fellow-student, which so well expresses my own views that I give it in his words:—

"We students were all very much impressed by the personality of Lister. His mild expression and his grave demeanour gave him benign dignity which could not fail to command respect. Even the impediment in his speech, which in another man might have been a source of annoyance to his hearers, seemed in his case only to add to the weight of what he said; and as he spoke slowly not a word of his lecture was lost. You remember how his students more or less unconsciously fell into a way of speaking which was a manifest echo of the master's voice. This affectation on the part of the students was simply an indication of the hero-worship which pervaded Lister's class, for there is no doubt we all idolised him.

"I understand it has been said of Lister that he was not a good lecturer, and that he was not a brilliant operator. You and I can laugh at such statements. Lister's lectures were all that could be desired. His subject-matter was always interesting—generally intensely so; his thoughts were clear and well defined, and he conveyed them to his hearers in choice and vivid language which left no doubt as to his meaning. As to his operating slowly, did he not tell us that the advent of anæsthesia by chloroform had rendered it unnecessary and undesirable to hurry through the work? Lister was thinking out and developing the antiseptic system at that time, and we were privileged to listen day by day as he informed us of his difficulties and how he proposed to overcome them; and so we watched the progress of those early stages which laid the foundation for the final triumph. . . . Above and beyond all petty details rises the towering personality of the man while the mind dwells fondly on the grandeur and beneficence of his achievements." (J. W. Allan.)

From another of Lister's Glasgow students, and one who was his house-surgeon in the Royal Infirmary, Dr. J. Coats (now Colonel Coats), who was among the first to practise antiseptic surgery in private, an interesting letter of reminiscences has been received, from which the following is culled:—

"One day when Lister was visiting his wards in the Glasgow Royal Infirmary, there was a little girl whose elbow-joint had been excised, and this had to be dressed daily. Lister undertook this dressing himself. The little creature bore the pain without complaint, and when finished she suddenly produced from under the clothes a dilapidated doll, one leg of which had burst, allowing the sawdust to escape. She handed the doll to Lister, who gravely examined it, then, asking for a needle and thread, he sat down and stitched the rent, and then returned the dolly to its gratified owner."

On one occasion on which Lister visited my wards in the Royal Infirmary, after he had been for some time in London, we were walking together from a ward in one part of the building to a ward in another, by means of a gangway of wood and glass, when Lister remarked: "Macewen, do you find this bridge a convenience to your work, for if so, you have to thank me, as I was instrumental in getting it put up?" I replied, "Yes, it is a convenience, but it is nothing compared to the greater gangway you provided, by which the patients after operation cross directly from the wards into the midst of life and health." I received a kindly look, a suppressed smile, and a pressure of the arm. . . .

In Edinburgh, though his system was met by some with determined opposition, it was adopted more or less thoroughly by others, and by many of the younger men enthusiastically. The students, though doubtful at first, began to observe his results, and soon became admirers of Lister and his work.

When Lister entered the clinical theatre of the old infirmary to deliver before a crowded audience his last lecture there, he was presented with a farewell address from the students. As he rose to reply, the air was rent with a rousing cheer that shook the building to its foundation. A cheer such as only British students—at rare moments—know how to give. It is spontaneous, and bursts like a blast from the throat of a whirlwind. Lister [illegible] fairly overcome. One who was near him, as a quiet observer, saw that he first became pale, and then a blush covered all his visible anatomy to the tips of his fingers. In a few moments he recovered, and said: "Gentlemen, I can recall my reception in the surgical theatre in Munich, on my visit to Nussbaum, where I was greeted with a German 'Hoch.' It was to me almost overpowering in its enthusiasm, but it was as nothing compared to this." (Dr. Young.)

That spontaneous outburst issuing from four hundred throats made amends for much. It was the laurel crown offered by the students. That rousing cheer reverberated through his whole being, and left such deep impression as doubtless would be with him to the end.

In the evening of his long life, when he stood apart from the honours which had been showered upon him, there remained to him the greatest of all rewards, a clear conscience and the knowledge that he had devoted his life to and had achieved a great work for the good of humanity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. A. D. ROSS, lecturer on natural philosophy in the University of Glasgow, has been appointed to the chair of mathematics and physics in the University of Western Australia.

AT a special meeting of the council of Hartley University College, Southampton, held on December 30, Dr. Alexander Hill, late master of Downing College, Cambridge, was unanimously elected principal at a salary of 1000*l*. a year.

MR. FRANK ROSCOE, who for the past twelve years has been master of method in the Day Training College of the University of Birmingham, has been appointed secretary of the Teachers' Registration Council.

THE general meeting of the Association of Public School Science Masters will be held at the London Day Training College, Southampton Row, W.C., on January 8 and 9; in connection with the meeting Dr. T. P. Nunn will deliver a series of addresses on the afternoons of January 6 and 7, upon "The Theory of Science Teaching, with Special Reference to the Conditions in Boys' Schools." On Wednesday, January 8, the president of the association, Sir Archibald Geikie, K.C.B., P.R.S., will deliver an address, and there will be a discussion upon the aims and uses of school science societies. On January 9 the subjects to be discussed are:—Practical examinations in science, the teaching of mechanics, and the value of presenting the historical aspect in teaching science. A paper urging that the teaching of density should be placed in the background and be superseded by the idea of "Roomage," or specific volume, will be read by Mr. G. F. Daniell.

WE learn from *Science* that by the will of the late Prof. Morris Loeb, formerly professor of chemistry in the New York University, large bequests are made to scientific and educational institutions. Subject to the life interest of Mrs. Loeb, 100,000*l*. is bequeathed to Harvard University for the advancement of physics and chemistry, 5000*l*. is left to the American Chemical Society for the establishment of a type museum of chemicals, to be established in the Chemists' Club of New York City, the U.S. National Museum, or the American Museum of Natural History, and 500*l*. is bequeathed to the National Academy of Sciences. The Hebrew Technical Institute receives 10,000*l*. The residuary estate, subject to Mrs. Loeb's life interest, is to be divided equally among the Smithsonian Institution at Washington and certain New York institutions, including the American Museum of Natural History, the Hebrew Technical Institute, and the Educational Alliance. The Smithsonian Institution receives its bequest to further the exact sciences. The American Museum of Natural History is to secure a collection for the illustration of the industrial use of natural products in ancient and modern times. The Hebrew Technical Institute is to establish technical courses for mechanics.

THE report of the hundred and sixteenth session of the Royal Technical College, Glasgow, which used to be known as the Glasgow and West of Scotland Technical College, is a record of satisfactory progress. The number of day students for the session 1911–12 was 572; of evening students, 4691; and of students in affiliated continuation classes, 8682. The college is therefore the centre of an organisation responsible for the education of 13,945 individuals. The corresponding number for the preceding session was 13,473. The increase in the number of day students was twelve. The roll of students contained the names of 157 graduates of the four Scottish universities, and of the Universities of Oxford, Cambridge, London, Manchester, Durham, Leeds, Sydney, Adelaide, Calcutta, Allahabad, and Heidelberg. Although seven large laboratories were provided for pure and applied chemistry in the new buildings recently opened, they have already proved insufficient, and, in consequence, an additional chemical laboratory, to accommodate seventy-two students, has been provided by transferring to the corridors on the same floor the contents of the museum of technical chemistry. Such rapid development of an industrial department is good evidence that the college maintains its position as possessing one of the leading schools of applied chemistry. The new lectureship in sugar manufacture, founded with the aid of subscriptions from firms and individuals interested in this industry, has been established. Proposals have been made for the establishment of a lectureship dealing with leather-tanning, but the governors are obliged to postpone taking steps in this direction until subscriptions are forthcoming to meet at least one-half of the probable expense, as was done in the case of the lectureship in sugar manufacture. In other departments of the college there are similar developments, and the report makes it clear that under its new name this Scottish technical college is entering on a career of increased usefulness.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, December 19, 1912.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Cecil H. **Hooper**: Experiments on the pollination of hardy fruits, with observations on the insect visitors to the blossoms. Strawberries, provided there is wind, set fruit well without insects. Raspberries and loganberries set fruit imperfect in shape if insects are excluded. Currants and gooseberries, owing to the construction of their flowers and pollen, cannot be pollinated and set their fruit without the visits of insects. All these plants set fruit perfectly with pollen of the same variety or even of the same flower; but in the case of the apple, pear, plum, and cherry, this is not always the case, many varieties being self-sterile, and almost all produce more abundant and finer fruit with pollen of another variety. In these trees there is little transference of pollen by the wind, and even if a self-fertile tree is enclosed in muslin whilst in blossom (there being ample movement of the wind, insects only being excluded), it is the exception for any fruit to set; it is the same with gooseberries and currants. In trials with apples, only nineteen varieties out of sixty-five proved self-fertile; in pears, four out of thirty; in plums, twenty-one out of forty-one; in cherries, five out of twelve; whilst, when cross-pollinated, in three-quarters of the trials one or more fruits set on a truss. There seems to be a preference as to pollen, some varieties setting better with pollen of one variety than with that of another;

and some varieties will not set with certain pollen. Out of nearly 3000 insects observed last spring visiting the blossoms of the various fruit bushes and trees, 88 per cent. were hive-bees, $5\frac{1}{2}$ per cent. bumble and other wild bees, and $6\frac{1}{2}$ per cent. flies, ants, beetles, wasps, and other insects; but the latter group have not fluffy bodies for carrying pollen, and amuse themselves eating the pollen.—H. M. **Chibber**: The morphology and histology of *Piper Betle*, Linn.

MANCHESTER.

Literary and Philosophical Society, November 26, 1912.—Prof. F. E. Weiss, president, in the chair.—Prof. F. E. **Weiss**: The root-apex and young root of Lyginodendron. This genus, one of the Coal-Measure plants, the remains of which are frequently preserved in the calcareous nodules of the Lancashire coal seams, is of peculiar interest, owing to the position assigned to it and allied genera. Fern-like in appearance, it is known to have borne seeds of considerable complexity, and it has therefore been placed in a newly established group of Pteridospermæ, between the true ferns and the flowering plants. As among other characters, these two groups are distinguished by the possession of a single cell or multiple group of such cells at the apex of their roots, an investigation of the root-tip of Lyginodendron is of some interest. Careful examination of numerous sections tends to prove that the structure of the root-tip of Lyginodendron agrees more closely with that of the ferns than that of the flowering plants.—Dr. Kurt **Loewenfeld**: The importance of autograph documents for the history of science (part ii.). The author dealt chiefly with letters by Priestley and Lavoisier. These included letters to Sir Joseph Bank and Josiah Wedgwood, and others relating to the Birmingham riots in 1791. The draft of a letter of the French chemists, offering to make good all Priestley's losses through the riots, was read. It is noteworthy, especially considering the scientific relations between Lavoisier and Priestley, that this draft had corrections by the hand of A. L. Lavoisier, which makes it evident that this letter originated from him.

DUBLIN.

Royal Dublin Society, December 17, 1912.—Prof. James Wilson in the chair.—J. **Adams**: The germination of the seeds of some dicotyledons. Investigations were made to determine how long the seeds of a particular species of plant remain in the ground before they germinate. Observations were made on 278 different species of plants belonging to 190 genera, and representing fifty-eight families. In some cases the seeds germinated after a few weeks, while in others, such as the hawthorn, a year and a half was required. The characters of 158 species not included in Lubbock's treatise are given. The majority of the seeds used were of British species, but a few exotic species, such as almond, fig, &c., were included.—Prof. T. **Johnson**: *Bothrodendron* (*Cyclostigma*) *Kiltorkense*, Haughton, sp. The paper treats of specimens obtained by the author at Kiltorkan, co. Kilkenny, and of others in the collections in Dublin and London. An attempt is made to prove that *B. Kiltorkense*, abundant at an epoch when Lepidodendron and Sigillaria were either non-existent or, if formed, still relatively rare, and showing pronounced calamitoid characters including transverse zonation (nodal diaphragms?) and vertical fluting—is the earliest and best representative of the ancestral stock from which the Lycopodiales and Equisetales took their common origin.—Prof. J. **Joly**: A method of microscopic measurement. This is one which apparently has not hitherto been applied in microscopy; it consists in observing with the camera lucida the object to be measured, in such a manner that its image appears upon a sheet of paper on which two lines have been drawn slowly diverging from a point. By shifting the paper the image is made to fit exactly between the lines, the position where it fits being marked. A similar operation is performed with a suitably divided millimetre scale. From the data so obtained a simple calculation gives the diameter of the object.—Prof. H. H. **Dixon** and W. R. G. **Atkins**: Osmotic pressures in plants. (*a*) Methods of extracting sap from plant organs; (*b*) osmotic pressures and electrical conductivities of the saps of plant organs. (*a*) Various methods of obtaining sap for microscopic conductivity measurements are discussed. It is shown that the sap pressed from living tissues may have a concentration very different from that in the vacuoles of the cells, the protoplasm of which must be rendered permeable before the unaltered sap can be pressed. Exposure to heat, toluene vapour, or chloroform is open to objection. Treatment with liquid air seems free from objection, renders the membranes permeable, and allows the unaltered sap to escape. Cryoscopic and conductivity measurements on this true sap show that it is usually much more concentrated than that pressed from the untreated organs. An extreme example of this is afforded by the leaf of *Chamaerops humilis*. (*b*) The fundamental error in previous cryoscopic and conductivity measurements of the sap of plants, which was pointed out in the foregoing paper (*a*), renders revision of previous results necessary. The present paper contains a number of results of cryoscopic determinations, osmotic pressures resulting from them, and conductivity measurements made on saps obtained from organs treated with liquid air.

EDINBURGH.

Royal Society, December 16, 1912.—Prof. Bower, vice-president, in the chair. Irvine **Masson**: The precipitation of salts by corresponding acids. If B is the initial solubility in pure water, and b the solubility for acidity a, then within fairly wide limits it is found that the ratio $a/(B-b)$ is a constant, on which the change of temperature seems to have little effect. Its value is very nearly unity for the chlorides and nitrates experimented with. The main object of the paper was to connect by means of this empirical formula the two recognised methods for studying experimentally these relations, namely, the "solubility" method, which determines directly the solubility of a salt in water containing the acid in varying concentrations, and the "precipitation" method, as used by Gibson and Denison, which aims at ascertaining the minimum concentration of aqueous acid which when added in small quantities to the saturated aqueous salt solution causes deposition of salt. Prof. **Seward** and N. **Bancroft**: Jurassic plants from Cromarty and Sutherland. The material included Hugh Miller's collection in the Royal Scott Museum, a section of a cone in Dr. Kidston's collection, petrified wood from Helmsdale lent by Dr. Horne, and two fossils found by Dr. Nathorst on the Sutherland coast. The examination of the material had led to the recognition of six new species, *Thinnfeldia scottica*, *Brachyphyllum eathiense*, *Masculostrobus Woodwardi*, *Conities Juddi*, *Cedroxylon Hornei*, and *Strobilites Milleri*. Prof. F. J. **Cole**: A monograph on the general morphology of Myxinoid fishes, based on a study of Myxine. Part V. The anatomy of the gut and appendages. C. Tate **Regan**: Antarctic fishes of the Scottish

National Antarctic Expedition. The fishes, which were collected in the vicinity of the South Orkneys, Falkland Islands, and Gough Island, include forty-eight species, of which ten are new to science. The report is supplemented with a monograph on the Nototheniidæ and related families, a revision of the Qoarcidæ, and notes on the systematic position and distribution of the Galaxiidæ. It also includes an account of a new genus taken in South Georgia, and named *Chaenocephalus salveseni*. Prof. Émile **Topsent**: the Porifera of the Scottish National Antarctic Expedition. Several new genera and many new species are described from high southern latitudes and also from great depths.

PARIS.

Academy of Sciences, December 23, 1912.—M. Lippmann in the chair.—Gaston **Darboux**: Surfaces of translation.—G. **Lippmann**: An electric time-measuring apparatus for the comparison of two periodic phenomena. An arrangement of two electrical contacts on a tube rotating at a known uniform rate, and each separately adjustable, so that the time elapsing between the two contacts can be made any fraction of a second, read directly from the instrument. As examples of applications of the instrument are given the comparison of two sidereal clocks, the reception of Eiffel Tower signals, and the emission of time signals. —Th. **Schlœsing, Jun.**: The detection and estimation of free white phosphorus in phosphorus sesquisulphide. The method is based on extraction with a low boiling petroleum ether, and subsequent determination of the ratio of phosphorus to sulphur in the residue left after evaporating the ether.—M. **Gouy**: The spontaneously ionised gases. A reply to some criticisms by C. G. Darwin.—M. **Guntz** was elected a correspondant for the section of chemistry in the place of the late M. Cannizzaro, and M. **Lehmann** a correspondant in the section of mineralogy in the place of the late M. Zirkel.—Kr. **Birkeland**: The source of the electricity of the stars. A discussion of the possibility of the stars and the sun becoming negative by the loss of positive electrons.—E. **Belot**: The material of satellites with respect to the density of the planets, their time of rotation, and their superficial structure.—D. Th. **Egoroff**: The integration of functions.—N. **Lusin**: The properties of Denjoy's integral.—P. **Montel**: The existence of derived functions.—W. H. **Young**: Fourier's series convergent nearly throughout.—S. **Lattès**: The reduction of linear substitutions.—M. **Nörlund**: Linear equations with finite differences.—Witold **Jarkowski**: The equation of the barogram of the ascent of an aëroplane.—Jules **Roux**: The law of Stokes and the charge of an electron. A study of the fall of sulphur spheres of small radius in xylene and the application of Stokes's formula, modified by Cunningham, to the results.—M. **Jouguet**: The stability of equilibrium of a system enclosed in a cover impervious to heat.—E. **Briner** and E. L. **Durand**: The action of temperature on the equilibrium of nitric and nitrous acids, formed by starting with the oxides of nitrogen and water. An increase in the pressure of the NO and lowering of temperature both favour the formation of nitric acid.—Auguste **Piccard**: The constitution of water and the thermal variation of its magnetisation. On the assumption that any body has a constant diamagnetism so long as there is no change of state the temperature coefficient of magnetisation described in an earlier paper has been applied to determine the constitution of water. The results are in general agreement with those deduced from the change of density with temperature.—J. A. **Muller**: The mode of ionisation of sulphuric acid in dilute aqueous solution. A discussion of the experimental data given appears to show that in dilute aqueous solution sulphuric acid ionises into the ions H and HSO_4, and this ionisation takes place with evolution of heat within the limits of temperature studied.—M. **Hanriot**: Tempering of metals without deformation.—Marcel **Ostwald**: Some properties of the alkaline nitrites. A description of the mode of preparation of the pure nitrites, followed by data relating to the appearance, melting points, densities of solids and solutions of sodium and potassium nitrite.—Daniel **Berthelot** and Henry **Gaudechon**: The photolysis of various bioses and trioses by the ultra-violet rays.—Jacques **Duclaux**: The polymerisation of bodies at low temperatures.—Œchsner de **Coninck**: The determination of the atomic weight of uranium. The value 238·4 is derived from the ignition of the oxalate.—Léon **Guillet**: The copper-zinc-nickel alloys.—Léo **Vignon**: The fractional distillation of coal. Five samples of coal were heated successively to 400°, 600°, 850°, 1000°, and 1200° C., and analyses made of the gas given off at each temperature.—Maurice **Lanfry**: The action of hydrogen peroxide on oxythionaphthene, oxythionaphthene-carboxylic acid and thioindigo.—P. **Carré**: Contardi's glycerotriphosphoric acid. An adverse criticism of Contardi's results.—Marcel **Godchot** and Félix **Taboury**: The bromination of *cyclo*pentanone.—A. **Mailhe**: The nitro-derivatives of the oxide of meta-cresyl.—Georges **Tanret**: The presence of stachyose in the bean and in the seeds of some other Leguminosæ. Stachyose forms a strontium compound, and this was utilised in the detection of this sugar in various Leguminosæ.—G. **André**: The hydrolysis and displacement by water of the nitrogenous and mineral matters contained in leaves.—Marin **Molliard**: The hypertrophiant action of the products elaborated by *Rhizobium radicicola*. An account of comparative experiments on the growth of the pea in water and in water containing the secretory products of the above-named parasite.—L. **Armand**: Germination and development of the embryo in the Lobeliaceæ.—Pierre **Teissier** and Pierre Louis **Marie**: Attempts at variolic serotherapy. —J. **Renaut**: The direct connective filiation and development of arterial muscular cells.—Jacques **Mawas**: The form, direction, and mode of action of the ciliary muscle in man.—Jacques **Pellegrin**: New contribution to the ichthyological fauna of Lake Victoria (Africa).—A. **Magnan**: The functional adaptation of the intestine in ducks. A reduction in the length of the intestine has been obtained experimentally by change of food.—D. **Keilin**: The structure of the pharynx in the larvæ of some Diptera as affected by the nature of the food. M. **Javillier**: The substitution of various chemical elements for zinc in the culture of *Sterigmatocystis nigra*. Cadmium is the only element analogous to zinc in its action on the growth of this fungus. The presence of a ten-millionth part of cadmium increases the yield 2·6 times.—Em. **Bourquelot** and H. **Hérissey**: The synthetical reaction between galactose and ethyl alcohol under the influence of kephir.—L. C. **Maillard**: The formation of humus and of mineral combustibles without the intervention of atmospheric oxygen, of micro-organisms, of high temperatures, or of strong pressures. The interaction of amino-acids with sugars gives brown condensation products containing nitrogen, and regarded by the author as analogous with the humus extracted from soil. Carbon dioxide is evolved in this reaction, which takes place in the absence of oxygen. This reaction is regarded as explaining the natural formation of humus.—Gabriel **Bertrand** and F. **Medigreceanu**: The temporary fixing and mode of elimination of manganese in the rabbit.—H. **Bierry** and Mme. Z. **Gruzewska**: A new method for the determination of glycogen in the liver. A modification of Pflüger's method, permitting more rapid estimations without loss of accuracy. Comparative figures are given for results obtained by the proposed method and that of Pflüger.—Maurice **Nicloux**: An experiment realising the mechanism of the passage of carbon monoxide from the mother to the fœtus.—Ch. **Pussenot**: The middle Westphalian in the alpine axial zone.—G. Gouré de **Villemontée**: A case of globular lightning.

E. A. **Martel**: The displacement of the thermal springs at Roosevelt Dam, Arizona.

CALCUTTA.

Asiatic Society of Bengal, December 4, 1912.—Dr. Sten **Konow**: Fragments of a Buddhist work in the ancient Aryan language of Chinese Turkestan. This paper gives an account of six MSS. leaves (forming part of a bulky work containing about 400 leaves) recovered from Khotan, and written in verse in what is provisionally designated as the ancient Aryan language.—Dr. N. **Annandale**: Contributions to the biology of the Lake of Tiberias. No. 1, an account of the sponges. The paper is the first in a series based on a visit to Palestine made in October, 1912, with the object of discovering whether the peculiar fauna characteristic of fresh water in tropical Africa and Asia, especially as regards the lower invertebrates, extends northwards up the Jordan valley. Considered as a whole the sponge fauna of the lake provides evidence (1) that a peculiar fauna of closely related species is being evolved therein; (2) that in this lake, as in others, there is a tendency for the Spongillidæ to lose their characteristic gemmules; and (3) that as the gemmules disappear the skeleton of the sponges becomes harder and more compact.—D. **Hooper**: The Ash of the plantain (*Musa sapientum*, Linn.). The ash of plantain leaves and stalks is used in India for various industrial purposes: as a mordant in dyeing, as a soap, medicine, table salt, and manure. Analyses of authentic samples show a variation in composition and alkalinity, and do not exhibit a greater value than ashes of other plants. There is evidence that the composition of the ash is influenced by the soil in which the plants are grown.—M. H. **Sastri**: A short note on Āyi Pantha, a newly discovered cult in the Bilāda District of the Mārwār State. The new religion was preached by women in the fifteenth century A.D. Its chief seat is at Bilāda in Mārwār. It has a perfect administrative organisation, and it has about a lac of adherents. The chief object of worship is a light kept up for the last 450 years fed by ghee. It emits no smoke, but a yellow substance called "Kesara," which means saffron. The lady preacher is known as "Āyi," and the cult is therefore called "Āyipantha." As Shams Tābrez is an object of reverence, this cult seems to be a survival of the ancient fire-worship of Irān.

BOOKS RECEIVED.

Handwörterbuch der Naturwissenschaften. Edited by E. Korschelt and others. Lief. 26 to 34. (Jena: G. Fischer.) Each 2.50 marks.

Beziehungen des Lebens zum Licht. By Dr. C. Neuberg. Pp. 63. (Berlin: Allgemeine Medizinische Verlagsanstalt G.m.b.H.) 1.50 marks.

The Moorlands of North-Eastern Yorkshire: their Natural History and Origin. By F. Elgee. Pp. xvi+361+illustrations+maps. (London and Hull: A. Brown and Sons, Ltd.) 12*s*. 6*d*. net.

The British Bird Book. Edited by F. B. Kirkman. Section x. Pp. 188+plates. (London and Edinburgh: T. C. and E. C. Jack.) 10*s*. 6*d*. net.

Notes on the Natural History of Hornsea Mere. By G. Bolam. (London and Hull: A. Brown and Sons, Ltd.) 1*s*.

Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege. By Prof. J. Formánek. Zweite Auflage. Zweiter Teil. 2 Lief. Pp. 165–366+plates. (Berlin: J. Springer.) 14 marks.

Abrégé sur l'Hélice et la Résistance de l'Air. By M. Gandillot. Pp. 188. (Paris: Gauthier-Villars.) 10 francs.

Bergens Museums Aarbok, 1912. 2det Hefte. Pp. 84+plates xxvii+152+plate i. (Bergen: J. Griegs.)

Bergens Museums Skrifter. Ny Rœkke. Band ii., No. 1. Vestlandske Graver fra Jernalderen. By H. Schetelig. Pp. iii+242. (Bergen: J. Griegs.)

DIARY OF SOCIETIES.

FRIDAY, JANUARY 3.

GEOLOGISTS' ASSOCIATION, at 7.—Some Valleys and Moraines in the Bergen District, Norway: H. W. Monckton.

MONDAY, JANUARY 6.

ARISTOTELIAN SOCIETY, at 8.—Intuitional Thinking: Prof. Frank Granger.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Estimation of Glyceryl Acetate in Essential Oils: S. Godfrey Hall and A. J. Harvey.—The Estimation of Moisture: F. H. Campbell.—The Determination of Moisture in Foods, etc.: W. P. Skertchly.—The Determination of Water: G. N. Huntly and J. H. Coste.

TUESDAY, JANUARY 7.

RÖNTGEN SOCIETY, at 8.15.—Spark Photographs at High Pressure: Prof. A. W. Porter, F.R.S., and W. B. Haines.—Some Relations between Kathode and Röntgen Rays: Dr. R. Whiddington.

WEDNESDAY, JANUARY 8.

GEOLOGICAL SOCIETY, at 8.—The Geological History of the Malay Peninsula: J. B. Scrivenor.—A Mass of Anhydrite in the Magnesian Limestone at Hartlepool: C. T. Trechmann.

THURSDAY, JANUARY 9.

CONCRETE INSTITUTE, at 7.30.—Concrete in its Legal Aspect: W. Valentine Ball.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Design of Apparatus for Improving the Power Factor of A. C. Systems: Prof. Miles Walker.

MATHEMATICAL SOCIETY, at 5.30.—The Reduction of Ideal Numbers: W. E. H. Berwick.—Proofs of Certain General Theorems Relating to Orders of Coincidence: J. C. Fields.

FRIDAY, JANUARY 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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NATURE

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

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THURSDAY, JANUARY 9, 1913.

SCIENCE AND TECHNOLOGY.

Treatise on General and Industrial Inorganic Chemistry. By Dr. Ettore Molinari. Third revised and amplified Italian edition. Translated by Dr. Ernest Feilmann. Pp. xvi+704. (London: J. and A. Churchill, 1912.) Price 21*s*. net.

THIS treatise, which is a translation of the third and amplified Italian edition, is divided into three parts, devoted respectively to general, non-metallic, and metallic chemistry. So far as English readers are concerned, it is open to doubt whether the general part (pp. 1–125) represents, in any sense, an improvement on the treatment of the subject to be found in standard works on historical and physical chemistry. In some cases, the views of the author are not such as would meet with unqualified acceptance by all chemists, and in these cases the translator has added emendatory notes, many of which occur in this general section (*e.g.* pp. 25, 49, 50). In the paragraphs devoted to the history of chemistry the author discusses, in some detail, the development of chemical arts among the ancient civilisations of the world. He holds that the Chinese in particular were adepts in these matters, and had actually anticipated Priestley and Lavoisier in arriving at a knowledge of oxygen and the composition of water.

The space allotted, in this section of the book, to various historical topics is not, however, proportional to their chemical interest and importance. A long footnote, occupying two-thirds of a page, refers to certain particulars in the life of Lavoisier which are of dubious import in a scientific treatise. Biographical criticism leaves us with so few illusions that we might have been spared a reference to the accusation brought against Lavoisier that he amassed, in a few years, 48,000*l*. as a *fermier-général*. This and similar items might with advantage have been replaced by such genuinely chemical matters as Rey's work on the calcination of metals, and Graham's researches on the diffusion of gases. The former of these investigators is not mentioned in connection with the anti-phlogistic theory, and the latter's experiments are dismissed in half a sentence (p. 39). A statement regarding the liquefaction of helium (p. 29) is contradicted by the facts cited on p. 312.

The descriptive portions (Parts 2 and 3) contain those distinctive features of the work which justify its translation into English. Here the author has indicated the industrial processes involved in the preparation of the more common elements and compounds, and in those cases where the manufacture has assumed considerable proportions, full details are given in order to emphasise the commercial importance of the subject. The manufacture of ordinary and fuming sulphuric acid, the utilisation of atmospheric nitrogen, and the production of hydrogen on a large scale are examples of these topics. A new departure consists in giving the commercial price of each substance, as well as a complete summary of its industrial applications. Statistics are employed to compare the past and present importance of the commoner chemicals.

In the case of manufactures carried on to a considerable extent in Italy, such as the production of sulphur and calcium carbide, the author gives interesting details on the influence of local conditions on the development of the industry. The section devoted to metals includes full accounts of the industrially important compounds of the alkali metals, the production of superphosphate fertilisers, the modern smelting of copper, and the manufacture of Portland cement. Even the less common elements are briefly mentioned, and their industrial applications indicated. The micrography of iron and steel is described in some detail, and illustrated by two phototype plates.

There are a number of minor typographical errors scattered through the book (*e.g.* pp. 110, 112, 153, 192, 265, 287, 317), some of which are not devoid of unconscious humour. Rutherford's name is effectively Germanised to Rutherdorf by the simple expedient of transposing two letters. Sulphur is said to be used in the winegrowing industry against a cryptogram (*sic*) which attacks the young bunches of grapes.

G. T. M.

THE PRODUCTION OF CANE SUGAR.

The World's Cane Sugar Industry, Past and Present. By H. C. Prinsen Geerligs. Pp. xvi+399+maps. (Altrincham: Norman Rodger, 1912.) Price 12*s*. net.

ABOUT the middle of the nineteenth century nine-tenths of the world's sugar was obtained from the sugar cane. At the close of the century the proportion had fallen to about one-half, and the industry was considered by many to be dying out. Then there came a revival; the quantity began to increase, and has since grown continuously. The proportion, however, remains much about the same as before, for there has been

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a concurrent increase in the quantity of sugar produced from beetroot. In fact, an equilibrium appears now to have been reached, sugar cane and beetroot contributing each about one-half of the world's total sugar, though sometimes the one preponderates a little, sometimes the other.

The cause of the decline was, of course, the development of the beet sugar industry in Europe. The revival has been due to the coalescence of a number of factors, chief among which are the Brussels Convention abolishing the bounty system, the Japanese acquisition and development of Formosa, the tariff privileges granted by the United States to the former Spanish colonies, and, "last but not least," as Mr. Geerligs points out, "the great advance of science in the province of sugar cane cultivation and cane sugar manufacture."

This last factor is the one which would be of chief interest to readers of NATURE: it is not, however, dealt with, except incidentally, in the book before us. The author thinks the time ripe for a connected survey of the past, the present, and the probable future of the cane sugar industry in the various producing regions. He has therefore collected and discussed a large amount of historical, industrial, and statistical information respecting each of the countries concerned in the production. An idea of the scope and method of treatment will be gathered from the following summary of the topics dealt with in a typical section:—geography, climate, area planted with sugar cane, cultivation, manufacture, import and export duties, consumption, exportation, and future prospects.

Whilst the greater part of the book is of value chiefly to specialists, the first two chapters are of somewhat wider interest. They give a general survey of the history of the sugar industry, both cane and beet; in them Mr. Geerligs describes how various economical and political conditions have influenced the production of sugar, and he explains fully the working of the bounty system and of the sugar "cartels" on the European continent.

The author prophesies great progress in the near future for the Philippines, which, since the American occupation, have shown much improvement in methods of cultivation. Cuba has made similar progress, though here the difficulty of obtaining labour is against rapid development in the future. Porto Rico, and, given stable political conditions, Mexico, are also considered to be countries where the cane sugar industry should increase largely.

C. S.

MONOGRAPHS ON BIOCHEMISTRY.

(1) *Oxidations and Reductions in the Animal Body.* By Dr. H. D. Dakin. Pp. viii + 135. (London: Longmans, Green and Co., 1912.) Price 4*s.* net. (Monographs on Biochemistry.)

(2) *The Simple Carbohydrates and the Glucosides.* Second edition. By Dr. E. Frankland Armstrong. Pp. viii + 171. (London: Longmans, Green and Co., 1912.) Price 5*s.* net. (Monographs on Biochemistry.)

(1) THOSE who have followed Dr. Dakin's work will be interested to learn his general conclusions as to the course of oxidation and reduction in the animal body. His monograph is logically arranged into general principles, including the nature of oxidising and reducing agents and the methods of investigation, and a detailed consideration of the results obtained for the various classes of chemical substances.

There is a striking difference between the amount of positive knowledge concerning the oxidation of fatty acids and of carbohydrates. This difference may be due to the greater ease with which the products of oxidation can be isolated in the former group. For instance, the following conclusions amongst others are reached concerning the catabolism of fats: the oxidation of saturated fatty acids leads to the formation of α- and β-unsaturated acids either directly or, more probably, through the intermediate formation of β-hydroxy- and β-ketonic acids; unsaturated acids give rise to the same products as do the saturated acids; they may take up water and form saturated hydroxy-acids; they may undergo direct oxidation at the double linkage; but di-hydroxy-acids such as are formed by *in vitro* oxidation of unsaturated acids are not intermediate products of biochemical oxidations.

Contrast with these the one definite statement about the carbohydrates:—"Lactic acid must therefore be regarded as one of the most important substances concerned with the intermediate metabolism of the carbohydrates."

This lack of balance is characteristic of a developing line of work, and does not imply any lack of effort. On the contrary, it is remarkable that so much information has been accumulated in a comparatively short time.

The unravelling of the processes of oxidation requires great care and patience. The methods of investigation are liable to lead to mistakes, but the author uses the results with due caution. He points out that when a supposed intermediate product gives the same end products as does the original substance, the deduction is that this product *may* be a step in the transformation, but if it does not do so, the reaction is practically certain to proceed by some other path.

From the whole tone of the book, one is led to place great confidence in the conclusions reached by the author. The collection of so many data in such accessible form is a great boon to biological chemists.

(2) The first edition of Dr. Armstrong's monograph was reviewed in Nature nearly three years ago (May 19, 1910). The second edition is larger, and the cost is greater.

This subject has such a large literature that there was some danger that the monograph might have been a condensation of some dull and monumental work. Fortunately, the author has avoided that entanglement, and has presented a comprehensive survey of his subject without making his book a chemical inventory. The chemistry of typical carbohydrates is described, and their relationship to other sugars is indicated. Excellent tables give the required data, so that the train of thought is not interrupted by unnecessary details. After reading the monograph, one can see a connection between α- and β-glucosides, their relation to enzymes, the cause of mutarotation, and many other interesting phenomena.

Both these monographs ought to be read by all physiologists and biological chemists, as they contain much information about their respective subjects, and in addition they are well written with a broad view as to the general problems involved.

H. E. R.

BOOKS ON FORESTRY AND ARBORICULTURE.

(1) *Illustriertes Handbuch der Laubholzkunde.* By Camillo Karl Schneider. Lieferung 6–12. Pp. v+1070. Price 34 marks. Register. Pp. vii+136. Price 5 marks. (Jena: Gustav Fischer.)

(2) *The Story of Our Trees in Twenty-Four Lessons.* By Margaret M. Gregson. Pp. xii+160. (Cambridge: University Press, 1912.) Price 2*s.* 6*d.* (Cambridge Nature Study Series.)

(3) *Forestry in New England.* A Handbook of Eastern Forest Management. By Prof. R. C. Hawley and Prof. A. F. Hawes. Pp. xv+479. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.) Price 15*s.* net.

(4) *Identification of the Economic Woods of the United States.* Including a Discussion of the Structural and Physical Properties of Wood. By Prof. Samuel J. Record. Pp. vii+117+6 plates. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.) Price 5*s.* 6*d.* net.

(5) *Lightning in Relation to Forest Fires.* By F. G. Plummer. Pp. 39. (U.S. Dept. Agric., Forest Service. Bulletin 111. Washington, 1912.)

(1) THE number of trees and shrubs in cultivation in the open air in this country is astonishing. Numerous new introductions have been made of late years, mainly from China, where the discoveries of Dr. A. Henry and Mr. E. H. Wilson have opened up an immense region, replete with new and hardy species. No complete treatise on the subject has appeared in English since Loudon published his classic work, "Arboretum et Fruticetum Britannicum," in 1838, and the abridgment, "Trees and Shrubs," in 1842. We have had to depend upon German text-books. The best of these, Koehne's "Deutsche Dendrologie," was published in 1893, and is now out of date.

We hail, then, with great pleasure the appearance of the concluding part of Schneider's great work, which deals with broad-leaved trees and shrubs, the conifers not being included. This is in two volumes, the first comprising 810 pages and 460 figures, the second 1070 pages and 628 figures, supplemented by a separate index of names, covering no fewer than 136 pages. The whole forms an indispensable text-book for all interested in arboriculture and horticulture. The descriptions are short, but accurate; the references are numerous and exact. Varieties and sports, which were omitted in Koehne's work, are briefly mentioned by Schneider.

As his regions of cultivation extend from the Baltic to Istria, most of the genera which are cultivated in England are taken up; but there are curious omissions. Eucalyptus is not referred to, yet no fewer than twelve species find a home in the west of England and Scotland, and in most parts of Ireland. The account of monocotyledonous trees and shrubs is very limited. While Yucca, Ruscus, Smilax, and Agave are included, no mention is made of palms like Trachycarpus, or of any of the bamboo tribe. A translation of Schneider's treatise into English would be a very useful book, which would, in all probability, command a ready sale.

(2) "The Story of Our Trees" is a book for school-teachers, apparently ignorant of botany, who wish to interest their pupils in the study of trees. There are twenty-four lessons, the best of which are those dealing with planting and felling. The author does not seem to be well acquainted with the special botany of trees, as she prefers often to take her illustrations from humbler plants. One would have selected the germination of the oak rather than that of the broad bean, which is

prescribed for study. The fruits figured include those of sweet pea, wallflower, pansy, and dandelion. There are curious errors. The "pine" cone figured on p. 11 is the cone of the common spruce. On p. 26, the casting of twigs, a peculiar process best seen in poplars (which are not mentioned in the vague account), is confused with the natural pruning of the branches of trees due to shade. The flowers of Eucalyptus and Cactus will not be available in many schools; and teachers are directed to purchase these in a shop somewhere in Yorkshire. There is no lack of material for the study of trees, even in large towns; and the lessons would be most valuable if all the material to be studied were gathered by the children themselves.

(3) "Forestry in New England" is an interesting book intended for the general reader. The first part is an account in simple language of the general principles of silviculture, with short chapters on cognate subjects, like forest fires, insect and fungoid pests, timber valuation and measurement, &c. The second part is more novel and valuable, being a description of the forests of New England at the present day. There are excellent chapters on their area, composition, modes of management, and financial returns. To the student of ecology, the account of the four forest regions, with their subordinate types, will be of great interest. The most important region, which includes the most elevated parts of the country, is dominated by the red spruce. The author mentions a remarkable fact, that wherever planting is resorted to, the European spruce (*Picea excelsa*) is a much superior tree to the native species (*Picea rubra*), as it grows much faster and yields better pulp-wood. The book contains much information that is new, and of great interest to both the botanist and the forester.

(4) Prof. Record's treatise is a most valuable contribution to our knowledge of the numerous kinds of wood which are of economic importance in the United States. The different species are admirably distinguished in the concluding part of the book. The first part presents, perhaps, in a clearer light than anything hitherto published in English the salient points in the study of the structural and physical properties of wood in general, each section being supplied with a well-chosen bibliography, which will be of great service to students. This book should be in the hands of foresters, architects, engineers and others who have to deal with the identification and uses of timber.

(5) In U.S. Forestry Bulletin No. 111, Mr. Plummer sums up an investigation that has been made in the United States on the liability of trees to be struck by lightning. Observations were taken during the past five years by nearly 3000 forest officers over a territory about 200,000,000 acres in area. Lightning is one of the chief causes of forest fires in America, being second only to sparks of locomotives as a source of conflagration. Lightning either ignites the tree itself, or probably more often sets fire to the humus at its base.

Mr. Plummer's conclusions are opposed to the current belief that some species of trees are more liable to lightning-stroke than others. According to Fischer's theory, oak and poplar, the wood of which contains much starch, are good conductors and attract lightning; while birch and beech, which have wood containing much oil, are bad conductors and escape. Mr. Plummer denies this, being of the opinion that "the greatest number of trees struck in any locality will be of the dominant species." He agrees, however, with previous writers that trees taller than others, those in an isolated position, and those with deep roots, are most in danger from lightning. Trees in general are most liable to be struck when their conductivity is increased, as is the case when their stems are wet with rain.

European statistics show that the species most often damaged by lightning on the Continent is the black Italian poplar (*Populus serotina*). The explanation is simple. This tree is extensively planted, always in more or less isolated positions, as along roads or in pastures, or on the sides of streams; moreover, it grows to a much greater height than the other species that are planted in similar situations. Mr. Plummer is in error in supposing this poplar, which is of hybrid origin, to be identical with the American *Populus monilifera*, which is usually a moderate-sized tree with a rounded crown, seldom struck by lightning in its native country.

OUR BOOKSHELF.

Primeval Man: The Stone Age in Western Europe. By A. Hingston Quiggin. With an introduction by Dr. A. C. Haddon, F.R.S. Pp. 140. (London: Macdonald and Evans, 1912.) Price 1*s.* 6*d.* net.

MRS. QUIGGIN has succeeded remarkably well in a praiseworthy attempt at striking the mean of anthropological opinion on primeval man, for the benefit of "the hard-working primary teacher or for upper forms." The value of that opinion on many points may be reasonably questioned, and the task of compiling a didactic work on the subject must have been a very difficult one. The author, however, cannot be held responsible for canvassed opinions. But who, in such a case, is responsible for the omission from such a book of most material evidence, as definitely scientific as any evidence summarised? There is very little in the book showing that any progress has been made in the interpretation of Neolithic monuments, the epithet "sepulchral" being applied to the archæological dead wall in that direction. The notion that the religion of the monument-builders is to be interpreted by existing savage life seems to be extremely fallacious, where evidence of a high culture is hypothetically reconciled with the lowest savagery (pp. 64, 65).

There is a body of other evidence of Neolithic culture which in this book is formally ignored, but just in the connection where one would expect a brief summary of that evidence, one finds the strongest expression, and by far the weakest argument, to be found in the book. "Popular belief generally attributes the megaliths to the Druids, but the connection is absolutely unsupported by evidence, and the idea is of recent (eighteenth century) origin" (footnote, p. 99). That there was no connection between the Druids and the megaliths is absolutely unsupported by evidence. The idea is certainly older than the eighteenth century, but it is to be admitted that the best evidence in point is as recent as the best on the classification of primeval skulls, in as bewildering an abundance as the latter is scarce, much less problematical, accessible to every archæologist, and so well appreciated when it can be understood that the blank, fruitless negations with which Mrs. Quiggin disposes of the subject materially assist, by demonstrating their own futility, in securing for the new evidence a fair examination.

JOHN GRIFFITH.

Katalog der paläarktischen Hemipteren (Heteroptera, Homoptera—Auchenorhyncha und Psylloideae). By B. Oshanin. Pp. xvi+187. (Berlin: Friendländer und Sohn.) Price 12 marks.

THIS useful list of Palæarctic Hemiptera and Homoptera is practically a fifth edition of Dr. Puton's "Catalogue des Hémiptères de la Faune Paléarctique," the fourth edition of which was published in 1899. The failing health and subsequent blindness of the French author prevented him from continuing the study of these insects, and M. Oshanin, therefore, has done good service by bringing the catalogue up to date. He takes a wider view of the Palæarctic region than Puton, including Wallace's Mandchurian subregion, that is, Japan and the greater part of China. Altogether, 5476 species are enumerated under fifty-five families and 1005 genera, and the classification adopted is that of O. M. Reuter. The year of publication of each of the genera and species, with the habitat, is given, as was done by Puton, and an alphabetical list of the species and varieties is to be found on pp. 131–177. The recently published "Verzeichnis der palaearktischen Hemipteren mit besonderer Berücksichtigung ihrer Verteilung im russischen Reiche," by the same author, gives a full reference to the works in which the species were described.

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.]

The Influence of Icebergs on the Temperature of the Sea.

IN the early 'seventies of last century I took considerable interest in oceanic circulation. Dr. Carpenter had previously shown that when the warm water moves from the equator towards the poles it gradually cools and sinks near the poles, and he showed that when this current meets with icebergs they have a cooling effect and produce downward currents; this he illustrated by placing some ice at one end of a tank of sea water, when a downward current was produced under the ice, which flowed away along the bottom of the tank towards the other end, where it rose and flowed back along the surface towards the ice. In 1873 I pointed out that Dr. Carpenter's description of the two currents did not give a full statement of what was taking place; that his surface current was not at the surface, but only near it, and that above it was another formed of a mixture of sea water and the fresh water of the melted ice, which had a lower specific gravity, though colder, than the sea water. This cold water flowed away from the ice over the surface of the warmer water. That the ice-cooled sea water was lighter than the sea water was also shown by dividing the experimental tank into two parts by means of a movable vertical partition. The water in one half was cooled by means of ice in varying amounts, and on removing the partition the cold water always flowed over the hot.

These are all laboratory experiments, and though they help us to understand something of what is taking place while ice is melting in sea water, yet they are not likely to contain all the conditions existing in nature. For this reason the recent investigations of Prof. Barnes on the rise of temperature near icebergs, found by him by means of his microthermograph, are most interesting, though I must admit very puzzling. In his Royal Institution discourse (NATURE, June 20, 1912) he gives a diagram of the temperature gradient of the sea water when approaching an iceberg. In this case, when at a distance of a little more than two miles from the berg, the temperature was rising, and rose 0·6 of a degree C. by the time the observing vessel had approached to within a mile of the berg. From this point the temperature began to fall, and at half a mile from the berg it had fallen 2·3°. On passing beyond the berg the temperature began to rise, and at a distance of about six miles it had risen about 1·7°, after which it began to fall.

In the very interesting and full diagram, showing the temperatures all round an iceberg, given by Prof. Barnes in NATURE of December 12, 1912, the temperature is shown to be rising on all sides as the berg is approached. Beginning to rise at a distance from it of five miles, it goes on rising right up to the berg, rising from 4·2° to 5·2° C. If these two diagrams represent something typical, why this difference in the two cases? In the first a rise of temperature stopping within a mile on one side and six miles on the other, and then a steady fall in temperature on both sides up to within half a mile of the berg, which was as near as it was approached; and in the other case a steady rise all round right up to the berg. There does not seem to be much difference in the conditions in the two cases so far as they are given in the papers; and as for the sea temperatures, they are alike, in both cases a little more than 4° C.

The two cases seem to me to represent two totally different conditions to which we have no clue. The first condition is what we might, according to the old theory, expect a ship would experience when sailing past a berg with a stern wind—the berg surrounded by ice-cooled water on the surface, extending one mile to windward and six miles to leeward, the temperature falling quickly when approaching the berg, and again rising slowly as the distance increased. In the second case this cold surface current is entirely absent, there is no fall of temperature as the berg is approached, but rather a decided rise of temperature, and the observer found no diluted sea water close to the berg. Still, that does not explain the difference. If the fall in temperature in approaching the berg in the first case was caused by diluted sea water on the surface, why was there none in the second?

As to the explanation of the rise of temperature when nearing icebergs, found by Prof. Barnes, in his Royal Institution discourse he attributes it to the sun's action on the fresher water of the surface current. He thinks that as the water of this current tends to keep to the surface and get warmed by the sun, it will have less tendency to mix with the lower water than sun-heated sea water; but as sun-heated sea water also tends to keep to the surface, any advantage in that way of the fresher water will not be great, and in both cases the mixing will be determined principally by the waves. Prof. Barnes, however, in his letter in NATURE of December 12, departs from this theory of surface heating, after finding there was no evidence of any weak sea water near the iceberg, and he now attributes the high temperature near the ice to a surface current which he thinks flows towards the ice. This current he considers will prevent the vertical circulation which elsewhere tends to keep the surface of the sea cooler; but he does not mention how, in the absence of ice, this vertical circulation is produced.

The results of Prof. Barnes's investigations are extremely interesting, but they are so much at variance with each other, and with the results obtained by others with less delicate methods, that we cannot help hoping he will continue his work under different conditions of temperature, &c., so as to help us to understand more clearly what is taking place near icebergs. In investigations of this kind, more information is required as to the size of the berg observed, since its size will determine the area of disturbance, and the amount of the deviation of the temperature from that of the surrounding area. We also require to know something about the force of the wind and the waves, as they have much to do with the mixing of the hot and cold waters; and information is also required as to the drift of the berg in relation to the surface water. If bergs surround themselves with indraught and outflow currents, then these currents will tend to have definite boundaries, and rapid changes of temperature may take place in small differences of depth. Thermometers at different depths might therefore give valuable information. We also require records of sunshine, as well as information with regard to the temperature of the sea at the depth of the bottom of the iceberg.

After reading Prof. Barnes's last letter I made some further investigations as to what takes place while ice is melting in sea water. The experiments are all laboratory ones, and therefore somewhat inconclusive, since, as I have already said, we cannot reproduce all the conditions in nature. Further, I may mention that owing to the distance to the nearest sea I had to experiment with common household salt and water of the density of sea water, but this is not likely to produce any important difference in the results.

The temperature circulation in the sea is profoundly modified by the presence of the salts. In a lake of fresh water attaining its maximum density at a temperature of about 39° F. the downward currents produced by surface cooling stop at about that temperature, and further cooling of the water causes it to tend to keep at the surface. In the sea, however, this is not the case, as sea water does not attain its maximum density until it is cooled much below 39° F. If the salinity be small, then the temperature of maximum density may only be lowered some two or three degrees below that of fresh water. But if the salinity be that of ordinary sea water, then the temperature of maximum density is below the freezing point of fresh water. We see from this that whenever sea water is cooled by the presence of melting ice it is made denser and so caused to sink. It is this cooled sea water which causes Dr. Carpenter's downward current.

One cannot help wondering what was the nature of the oceanic circulation before the salts began to accumulate, and how this circulation was gradually modified and the temperature at the depths slowly lowered to what it is at the present day.

It seems strange that when ice is melting in sea water we should have Dr. Carpenter's downward current of cold water, while parallel with it all round the ice there should be a rising current of cold but weak sea water; and one of the questions which suggested itself was: Is there any intermingling of the oppositely flowing streams? Does the cooled weak sea water of the upward current mix with the cooled downward one. In other words, does any of the melted ice go to mix with and cool the downward current? To test this point some ice was prepared by freezing some water which had been previously well boiled to expel the air, so as to avoid any air bubbles in the ice which might aid the rising current. Before freezing there was added to the boiled water a little aniline blue. The product was a piece of transparent blue ice. This ice was moored in the sea water at about mid-depth, so that there was water both above and below it. As the ice melted a stream of blue water was seen rising from it and spreading itself over the surface of the water, but not a vestige of blue could be detected in the bottom water, showing that the downward current is cooled by radiation.

Another question that may be asked is: May not the downward current overpower the upward one? If the ice goes deep down in the water the descending current will gain volume and velocity as it descends; may it not, therefore, overcome and carry down the melted ice current? Of course, one cannot in a laboratory get a satisfactory answer to such a question. The best I could do was a miniature berg of about one foot deep. A rod of blue ice of that length was prepared. This was placed vertically in a tall jar of sea water and the currents noted, but no difference in the circulation could be seen. A current of blue water flowed up close to the rod, and a downward cold current flowed to the bottom, but no blue went to the bottom of the jar. The rod, instead of standing vertically, was next placed at a considerable angle; but even then all the blue went to the top, the cold blue water, though it no longer travelled along the rod, but left it and rose over the rod, fighting its way to the surface through the clear water.

In order to study what takes place in the neighbourhood of melting ice the following experiment was made. In a vessel of sea water was moored, at a small distance from the surface, a piece of clear ice (see Fig. 1). By means of a pipette the end of which was drawn out into a long capillary tube, a fine line was drawn through the water in aniline blue dissolved in some of the sea water. The tube being very fine, no disturbance was made by its passage through the water, and the coloured line remained quite distinct. A straight line was drawn horizontally a little above the top of the ice and its deformation by the currents was watched, and the results are shown in the figure. The end of the line over the ice quickly curved upwards towards the surface. At a short distance from the ice it slowly bent downwards, and the successive positions it assumed are shown in the figure. Next the ice the line kept only a small distance from it all the way down, the upward current flowing between it and the ice, while the downward current carried the line down to the bottom of the ice, where it curved under the ice and was carried to the bottom of the water.

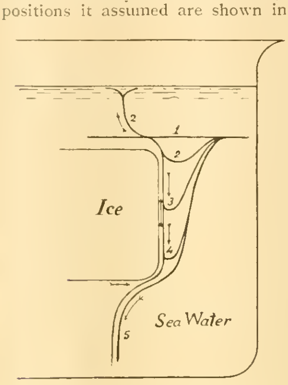

FIG. 1.—1, the coloured line drawn through the water; 2, 3, 4 and 5, position of the line at successive intervals of time produced by the currents.

There is still another question to which an answer is required. In these experiments all the water is at the same temperature, while in the sea this is not the case; the temperature there falls with the depth. And the question now is: How will this affect the circulation? Will the cold melted ice and sea water rise up through the warmer water? To get an answer to this question a tall jar about one foot deep was filled with sea water and surrounded for fully half its depth with ice and water. No salt was put in the cooling mixture lest the low temperature so produced should cause some of the sea water to freeze and so increase the density of the bottom water and interfere with the circulation. The water in the jar was cooled until the bottom temperature was 34° F., the surface temperature 41°, and the temperature at mid-depth 37·5°. A long rod of blue ice was now placed in the water. The rod extended from the bottom to the surface. The result was that all the blue as before came to the surface, showing that even the fall of temperature with depth in the sea does not seem likely to interfere with the rise of the ice-cooled water. This result might have been anticipated, because the ice-cooled water tends to rise at whatever temperature the melting takes places, and, having started to rise, it gradually acquires the temperature of the warmer water through which it rises.

All these tests tend to prove that the ice-cooled sea water will come to the surface, while Prof. Barnes's latest investigations on icebergs show that in certain cases it does not. I am sure the readers of NATURE will look forward with interest to any further observations Prof. Barnes may make with his very ingenious and delicate microthermograph, which may help to clear up the difference he has observed in the surface water surrounding different icebergs, and also the difference he has found in actual icebergs compared with laboratory experiments. Prof. Barnes, in your issue of December 12, gives a sketch to show the way in which he thinks an iceberg is eaten away by the sea water. The current is shown flowing on the surface towards the iceberg and eating it away quickest at the line of flotation. On looking at the sketch one cannot help asking, What has become of the light ice-cooled water? Should anyone be fortunate enough to see an iceberg tumble over on its side he may gain some information from an examination of its shape and from noting where the greatest amount of eating away had been done. But for his observations to be of value he would require to know something about the temperature of the sea at the bottom of the iceberg as well as at the surface; because, while ice melts quickest at the bottom, where the rising current first comes in contact with the ice, if the temperature is the same all the way down, yet we cannot expect this to happen if the temperature at the bottom of the berg is much lower than at the surface.

JOHN AITKEN.

Ardenlea, Falkirk, December 27, 1912.

AMUNDSEN'S ANTARCTIC EXPEDITION.[1]

MR. MURRAY has produced in a singularly attractive form a remarkably clear and readable translation by Mr. Chater of Captain Roald Amundsen's account of his expedition to the Antarctic regions in the *Fram*, which culminated in the attainment of the south pole, and settled the last of the old romantic problems of exploration. The main and avowed object of Amundsen's expedition was to reach the pole; everything else, including scientific observations, was merely incidental, so that at first sight it might appear that little notice need be taken in a scientific journal of the story of a big piece of record-breaking. In other places the ethics of record-breaking have been freely discussed in connection with this expedition, and the question has been raised whether it is decent and permissible for two explorers to try to reach the same point at the same time from different bases and by different means. The controversial aspects of Captain Amundsen's book do not concern us here, nor need we allow our national feelings to affect our opinion as to the manner in which the Norwegian expedition was designed, executed, and described.

The pursuance of the main aim of the expedition was a splendid example of efficiency in plan, equipment, transport, physical strength and skilled leadership. The plan was simplicity itself. It was to land and set up winter quarters on the Great Ice Barrier at 163° 30′ W. and 78° 30′ S., to form depots at intervals as far south as 82° before winter set in, and to store the farthest depot with sufficient food to carry a sledge-party from there to the pole and back and leave enough in reserve to secure their return to the base; then in the Antarctic spring to travel with light sledges and many dogs to the farthest depot, there to complete supplies and proceed due south to the pole, trust-

[1] "The South Pole." An Account of the Norwegian Antarctic Expedition in the *Fram*, 1910–1912. By Roald Amundsen. Translated from the Norwegian by A. G. Chater. Vol. i., pp. xxxv+392+plates+map. Vol. ii., pp. x+449+plates+maps. (London: John Murray, 1912.) Price, 2 vols. 2*l* 2*s*. net.

ing to find a way from the surface of the Barrier to the summit of the plateau on the meridian along which the route was directed, lightening loads by depositing sufficient supplies for the return journey to the next depot to the north at intervals of a degree of latitude.

Thanks to the careful choice of his companions, his dogs and his stores, Amundsen succeeded without a hitch. He took great risks, but the skill and preparedness of himself and his companions reduced these risks to a minimum. On the whole, the weather favoured him; but that was largely because he was able to distinguish the nearly invisible line between perseverance and stubbornness and to return to winter quarters after his first start on the great journey to the south when the severity of the weather began to tell on the dogs.

What distinguishes this expedition from all other polar sledging journeys is the fact that there was never a lack of provisions, not even of fresh meat, for no less than sixty tons of seal carcases had been prepared, and three tons of provisions carried to the depots at 80°, 81°, and 82°, the last being one-third of the way to the pole.

The incidents were only those familiar in Antarctic travel, the avoidance of crevasses on the Barrier, not only near the land, but in one or two places where the vast block of ice seems to have yielded locally to stresses of unknown origin, the negotiation of the Devil's Glacier, by which the ascent of the plateau was made through the mountain range about 160 miles south-east of the Beardmore Glacier, which served as Sir Ernest Shackleton's stairway, and the long journey across the lofty snow surface of the plateau until the immediate neighbourhood of the pole was reached. The telling of them reveals the point of view of the explorers, which differs somewhat from that often taken by persons of other nationalities, displaying an indifference to physical comfort and a resistance to fatigue that appear remarkable, while at the same time there is a general levity of spirits which, unless one reads between the lines, might mask the unshakable determination which drove the united party of five straight to their goal. Unfortunately, no precise data as to the health conditions are available, as the expedition did not include a medical man. As regards clothing, the system of woollen underclothing and wind-proof outer garments introduced by Captain Scott was used only for moderate temperatures. In extreme cold Captain Amundsen's party fell back on fur clothing. They introduced a new form of tent more quickly erected and more proof against the weather than that hitherto used, and of a particularly dark colour to reduce the glare of light which interferes with sleep in the unending sunshine of the polar day.

FIG. 1.—On Scott's Nunatak. From "The South Pole."

The scientific results, with the exception of those on oceanography, are of trivial importance, but they yield some scraps of new information and help to confirm the important facts discovered by Captain Scott, Sir Ernest Shackleton and others.

The results of the expedition, as regards geography, consist in the confirmation of Shackleton's discovery that the south pole was probably situated on a plateau more than 10,000 feet above sea-level; and of the extension of the great coast range of South Victoria Land with peaks of undiminished height in a south-easterly direction to latitude 88° S. at least.

It appears that this can no longer be regarded as merely a coast range, for Amundsen brings evidence to show that the Barrier, which represents the area believed to belong to the sea, terminates about 80° S., and there a spur of mountains runs off at right-angles to the main range in a north-easterly direction. There is no certain indication as to whether this range runs on to King Edward Land or not. The determination of the position of the pole on the uniform level surface of the plateau was accomplished by sextant observations with artificial horizons, the altitude of the sun being observed at hourly intervals by four separate observers for more than twenty-four hours. The readings are not given, but the result, as calculated by Mr. Anton Alexander, shows a latitude between 89° 57′ and 89° 59′ S.

Geological observations were confined to bringing home about fifty rock specimens from the mountains of South Victoria Land and from Scott's Nunatak on King Edward Land, which was visited for the first time by Lieutenant Prestrud in an interesting subsidiary expedition. The examinaton of the specimens shows that they consist only of granitic and schistose rocks.

The meteorological observations taken at the Bay of Whales at 78° 38′ S. do not cover a full year, but were taken three times daily from April 1, 1911, to January 29, 1912. The warmest month was December, with an approximate mean temperature of $-6{\cdot}6°$ C.; the coldest, August, with an approximate mean temperature of $-44{\cdot}5°$ C. The highest reading observed on the warmest day was just below freezing point. There was a marked predominance of easterly winds, this direction being most frequent with storms. It is almost incredible that there were no minimum thermometers on the expedition, and the maximum thermometers proved unworkable. Much snow was experienced at the base, but the stakes set out on the Barrier farthest south to mark the depots in autumn remained unconcealed after the winter's snowfall in the following spring, showing no appreciable accumulation of snow in eight months.

FIG. 2.—Hell's Gate on the Devil's Glacier. From "The South Pole." Reproduced by permission of *The Illustrated London News.*

The oceanographical observations are discussed by Prof. Helland Hansen and Dr. Nansen, who point out that the preliminary trip in the North Atlantic in 1910 furnished results of great value for comparison with those of the simultaneous voyage of the *Michael Sars* under the charge of Sir John Murray and Dr. Hjort.

During the wintering of the land party in 1911 the *Fram* made two complete oceanographical sections in the South Atlantic about 700 miles apart and comprising sixty stations between South America and Africa, furnishing material of the utmost value concerning the circulation of the ocean. This will certainly prove to be by far the most valuable result of the expedition, and will be of special importance in comparison with Dr. Bruce's fine work in the *Scotia*.

There is little reference to biological observations, the most interesting point noticed being the discovery of lichens on Scott's Nunatak on King Edward Land. HUGH ROBERT MILL.

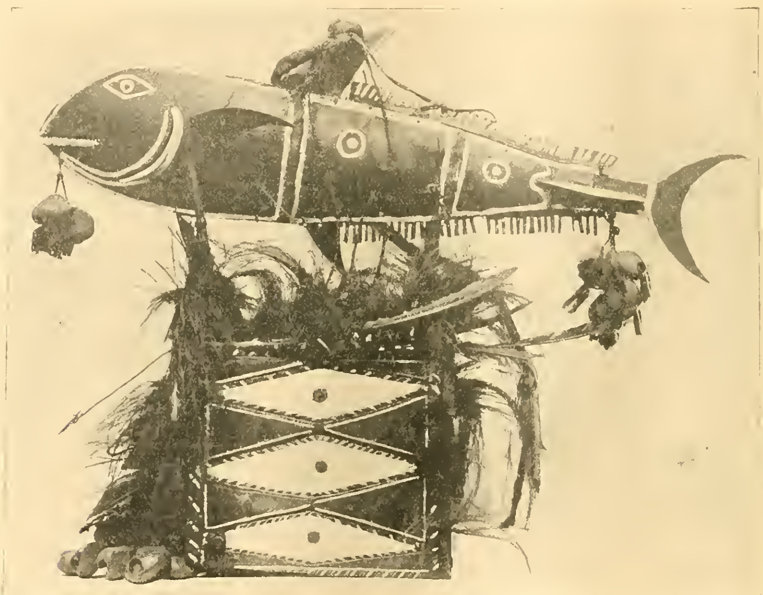

FIG. 1.—Box-mask with a bonito, made in Moa, obtained in Nagir. British Museum. The fish is 71 cm. (28 in.) long. From "Reports of the Cambridge Anthropological Expedition to Torres Straits." Vol. iv., Arts and Crafts.

ARTS AND CRAFTS IN THE TORRES STRAITS.[1]

THE fourth volume of the Reports of the Cambridge Anthropological Expedition to Torres Straits deals with the arts and crafts of the islanders, and the labour involved in its production is probably greater than that which went to the making of any other volume of this almost classical series. The writing up of technological data is laborious in the extreme, and, moreover, requires a special knowledge in many departments of human activity. Yet in spite of this the greater portion of the volume is the work of Dr. Haddon, the catholicity of whose anthropological knowledge appears to full advantage. He is responsible for the sections on daily life, decoration of the person, personal ornaments and clothing, domestic utensils and tools, food and its preparation, horticulture, hunting and fishing, weapons, transport and canoes, sound-producing instruments, songs, dances and dance-paraphernalia, games and toys, and the important chapter on art. He has also edited and completed the section on houses, which the untimely death of its author, the late Anthony Wilkin, had left unfinished. A very valuable chapter on textiles (baskets and mats) is contributed by Mrs Hingston Quiggin; Dr. Rivers deals with astronomy, Dr. Myers with music, and Mr. Ray with greetings and salutations and the calendar. Mr. J. Bruce contributes to the section on various social customs.

The book gives a practically complete picture of the economic and artistic life of a people who were hampered by several important restrictions; on the one side lack of water, ignorance of pottery and the carving of wooden vessels, on the other the want of efficient tools and the entire absence of metal. To deal with it at length is beyond the scope of a short notice, and it is possible only to direct attention to a few of the most interesting features.

Torres Straits has not been untouched by ex-

[1] "Reports of the Cambridge Anthropological Expedition to Torres Straits." Vol. iv., Arts and Crafts. Pp. xxiv + 393 + xl plates. (Cambridge: University Press, 1912.) Price 25s. net.

ternal influences, and, as might be expected, the neighbourhood of New Guinea has had great effect upon the ethnography. Australian influence, on the other hand, appears to have been very slight, though at least one of the tattoo designs characteristic of the islands has found its way to Cape York. More unexpected is the presence in Mer of a form of shell pendant representing the larva of the ant-lion, which appears to have been introduced by a native of the New Hebrides. The practice of moulding the heads of infants, in the desire to give them a shape so far as possible removed from that of the Australian, seems to hint at some racial antipathy, in spite of the fact that one of the heroic figures of Torres Straits mythology appears to have been a native of Cape York. The harpooning of dugong and the capture of turtle by means of the sucker-fish are treated in full, and are interesting since the methods are peculiar to these islands. In this connection one would venture to disagree with Dr. Haddon's use of the word "butt" to designate that end of the harpoon-shaft into which the point fits; surely this term can be applied only to the other end.

Fig. 2.—Top-spinning, Mer. From "Reports of the Cambridge Anthropological Expedition to Torres Straits" Vol. iv., Arts and Crafts.

The native canoe is explained in painstaking detail, and this section would be even more valuable if a sketch-plan of a typical native craft had accompanied it. It might be suggested also that "baler," and not "bailer," is the proper term for the utensil with which canoes are baled. In dealing with the native art, Dr. Haddon is handling a subject of which he has made a particular study, and the result is excellent. Besides purely formal patterns, the figures of fish occur most often in native design, but the people of Torres Straits are noteworthy as having risen in one or two cases to the portrayal of scenery, an accomplishment extremely rare amongst primitive folk.

The subject of the degeneration of patterns receives full treatment and is very illuminating, but the section on the names and significance of patterns and designs is disappointingly short. This, however, is due to no fault of the author, but to lack of information. While speaking of degeneration, we may congratulate Dr. Haddon for his ingenuity in discovering that a peculiar ornament, now worn only at dances, is the survival of the spare bowstring carried on the arm by warriors in the bad old days. Of amusements, top-spinning holds first place, and was pursued with such devotion by the natives that, as cricket in Fiji, it had to be limited by legislation. Dr. Rivers's chapter is one of the most complete and extensive discussions of the astronomy of a primitive people which has appeared, and the indications which he gives of the existence of private property in constellations are particularly interesting.

The entirely adequate treatment of such diverse material may be assumed from the unimportant nature of the criticisms made above. It should be added that the illustrations are furnished on the most generous scale, and consist of forty well-printed plates and nearly 400 line-drawings, of which those included in the chapter on textiles deserve a special word of praise. If anything is lacking at all it is perhaps in the binding, since in the particular copy under review the explanation of Pl. XVI. is duplicated, while that for Pl. X. is missing. To speak generally, all that need be said is that no one who sets out to deal with the art and technology of a primitive tribe can find a better model for the presentation of his results than the volume discussed above.

LÉON PHILIPPE TEISSERENC DE BORT.

The announcement of the death of M. L. Teisserenc de Bort, which appeared in *The Times* of Monday, January 6, will be received with profound regret by meteorologists in all parts of the world, for he was conspicuous among the pioneers in the investigation of the upper air. The history of his connection with that investigation is one of the most encouraging episodes of modern physical science.

Born in Paris on November 5, 1855, the son of an engineer, with ample private means, he began his scientific career in 1880 at the Bureau Central Météorologique as *chef de service* of the department of general meteorology, under the directorship of Mascart. His interests were wide. He spent his vacations in 1883, 1885, and 1887 in the study of terrestrial magnetism and geology in Algeria and Tunis, including the Sahara. In later years his leisure hours were mostly devoted to painting in oils. He remained unmarried.

His contributions to general meteorology while still an official of the Bureau mark him out at once as belonging to the school that regards the treatment of the meteorology of the globe in its entirety as a condition for effective progress. His charts of the distribution of pressure at the level of 4000 metres are a real contribution to the practical study of the general circulation of the atmosphere. They were preceded by studies of the distribution of pressure, winds and clouds, which introduced the idea of "centres of action." They were followed, after he had left the Bureau, by the book on "La Météorologie dynamique—Histoire de nos Connaissances," written in conjunction with his older friend H. H. Hildebrandsson, now emeritus professor at Upsala, and by the proposals now represented by the Commission du Réseau Mondial for putting the study of daily weather upon a "world" basis by collecting daily telegrams from about thirty stations distributed over the whole globe.

In 1892 he was excused from further daily attendance at the Bureau Central, and became *météorologiste* to the Bureau, presumably unpaid, and free to work in his own way. In 1896 he founded an observatory for the study of dynamical meteorology at Trappes, on an open plain near Paris, not far beyond Versailles. The first object of the new observatory was to carry out measurements of clouds in connection with the scheme of the International Meteorological Committee for cloud observations in the years 1896–7. That purpose satisfied, Teisserenc de Bort went on to study the upper air by means of kites, in association with his friend Rotch, the founder of Blue Hill Observatory, whose untimely death occurred only last year. His chapter of accidents with stray kite-wires is known to some of his friends, but is not published.

The next stage was a paper in the *Comptes rendus* of June 15, 1908, containing an account of three ascents of sounding balloons, *ballons sondes*, according to the plan suggested by Hermite and Besançon, whereby records on self-recording instruments are obtained from heights up to nearly thirty kilometres in exceptional cases, far beyond the limits attainable by manned balloons. The three ascents of June 8, 1898, had become ninety records by August, 1899, and 1100 records by 1906; and by that time it had been clearly proved that our atmosphere is divided into two shells by a surface at a height of about ten kilometres, just above the level of the highest clouds. In the upper shell, which Teisserenc de Bort called the "stratosphere," there is practically no change of temperature in a vertical column; below that is the lower shell, the "troposphere," the region of vertical temperature gradient and convection. Teisserenc de Bort used balloons of varnished paper, which do not so easily reach great heights as the expanding india-rubber balloons introduced by Assmann; so that the honours of the identification of the stratosphere are divided, but the name is Teisserenc de Bort's.

This achievement secured, his energy and enterprise were indeed astonishing. He managed to get corresponding investigations carried out (probably at his own charges) over the Danish seas, in the high latitudes of Sweden, over the Zuyder Zee, the Mediterranean, and subsequently over the intertropical region of the Atlantic Ocean. For the last-mentioned investigation, in the most critical period of the war between Russia and Japan, he bought a Hull "fish-carrier" (after selling his large house in Paris). The vessel was transformed into the s.y. *Otaria*, which was equipped and manned with the assistance of his friend Rotch, and made two voyages to study the currents above the trade winds.

The thermal condition of the stratosphere being more or less settled, Teisserenc de Bort next set himself to determine its chemical composition by capturing samples for analysis from a height of twelve or fourteen kilometres, but as yet no striking results have been obtained.

Teisserenc de Bort was always a delightful companion, and frequently a charming host at international meetings of meteorologists. No one knew better that meteorology is a cooperative science, and no one was more ready to help his colleagues. From 1903 onwards he paid frequent visits to England or Scotland. In the course of one of these visits he formed the acquaintance of Prof. Chrystal, and was invited to give a lecture before the Royal Society of Edinburgh. In 1908 he came to London to receive the Symons medal of the Royal Meteorological Society, bringing with him the first samples of his raid upon the stratosphere. He was never robust, and always most careful, but increasing ill-health kept him away from the meeting of the Commission for Scientific Aëronautics at Vienna in 1912, and he was away from the Time Signal Conference at Paris in October for the same reason. A New Year's card received only last week spoke of exhaustion following enteritis, which has apparently brought to a close at the early age of fifty-seven a career still full of promise, but yet triumphant in its accomplishments. It is only recently that he was elected a member of the Academy of Sciences, for which meteorology has to count as physics, although meteorology is a cooperative science, and physics, as generally understood, is distinctly individualist. But what is of more importance is that, by his maintenance of the observatory at Trappes, Teisserenc de Bort enabled France to keep her place in the front rank of the scientific investigation of the upper air. The provision for the future will be looked for with anxious interest. W. N. SHAW.

NOTES.

SIR HENRY ROSCOE celebrated his eightieth birthday on Tuesday, January 7, at his country house, Woodcote Lodge, West Horsley. His former students and friends having decided to commemorate the occasion by the presentation of his bust to the Chemical Society of London as a tribute of appreciation of his long life and work, a representative deputation visited him on Tuesday to convey to him the congratulations of his former students and to acquaint him with their proposal for the commemoration of his birthday. The deputation consisted of Sir Edward Thorpe, C.B., F.R.S., who acted as chairman, Prof. Smithells, F.R.S., Prof. Bedson, Dr. Charles A. Keane, Dr. A. Harden, F.R.S., Prof. Crossley, F.R.S., Mr. E. J. Bevan, and Mr. Watson Smith. A congratulatory address was presented, in which reference was made to Sir Henry's continued and successful services to chemistry and to the large debt of thanks that was owed to him by his pupils, his science, and his country. It was pointed out that although it was twenty-seven years since he resigned the chair of chemistry at Owens College, his influence as their teacher and friend had continued, and that amongst his former pupils there were many who, thanks to the teaching they had received at his hands, had been enabled to contribute to the advancement of science, and in their turn, both in academic work and in industry, had been privileged to train a second generation of men, whose labours it was hoped would add further testimony to the value of his guidance and example.

THE Royal Geographical Society has convened, for January 15, in the Theatre, Burlington Gardens, at 4.30, a special general meeting with agenda of much interest and considerable moment. The question of the admission of women to the fellowship of the society is again to the fore. It was the subject of discussion, not unaccompanied by heat, in 1893, when the opponents of the proposal enforced their view, having a technical point of procedure to strengthen the foundation of their arguments. On the present occasion the supporters of the proposal who take part in the meeting will have the knowledge of the existence of a preponderant body of opinion among the fellows generally in favour of the resolution which will be brought forward :—"That the society approves of the election of women as fellows," for a postcard referendum has been taken, with a result which has been announced as follows :—"Yes," 1796; unsigned, 43; "No," 578; conditional, 33.

WE regret to see the announcement of the death, in his eighty-first year, of M. L. P. Cailletet, whose work with Pictet on the liquefaction of gases, in 1877 and 1878, is memorable in the history of physical science.

THE twenty-first anniversary of the Institution of Mining and Metallurgy will be celebrated by a conversazione to be held at the Savoy Hotel on Monday next, January 13.

PROF. J. E. DUERDEN, Rhodes University College, Grahamstown, South Africa, has been invited by the Government of British East Africa to visit the Protectorate to lecture and advise upon ostrich-farming.

THE Secretary of State for War has approved of the following appointments on the Army Medical Advisory Board :—As civilian physiologist, Dr. Leonard Hill, F.R.S., and as civilian sanitary expert, Dr. Henry S. Kenwood.

SIR SYDNEY OLIVIER, K.C.M.G., Governor of Jamaica, has been appointed to be permanent secretary of the Board of Agriculture and Fisheries.

THE tenth International Congress of Agriculture will be held at Ghent, Belgium, on June 8–13, concurrently with the International Exhibition. The work of the congress will be classified under the following five heads :—(1) Rural economy; (2) science of agriculture, special crops, and agricultural education; (3) cattle-breeding; (4) agricultural engineering; and (5) forestry. A strong British committee, under the chairmanship of Sir George Fordham, is being formed to secure adequate representation of this country at the congress. Further particulars may be obtained from the secretary to the British committee, Craven House, Northumberland Avenue, W.C.

ON Tuesday next, January 14, Prof. W. Bateson will begin a course of six lectures at the Royal Institution on the heredity of sex and cognate problems; on Thursday, January 16, Mr. Seton Gordon will deliver the first of two lectures on birds of the hill country; and on Saturday, January 18, Dr. H. Walford Davies will commence a course of three lectures, with musical illustrations, on aspects of harmony: (1) "Chord Progression"; (2) "Added Dissonance"; (3) "The New Whole Tone Chord and its Predecessors." The Friday evening discourse on January 17 will be delivered by Sir J. J. Thomson on further applications of the method of positive rays, and on January 24 by Prof. J. O. Arnold on recent advances in scientific steel metallurgy.

THE President of the Board of Education has appointed an advisory council for the Science Museum. The council will be asked to advise the Board on questions of principle and policy arising from time to time, and to make an annual report on its proceedings to the Board, together with any observations on the condition and needs of the museum which it may think fit to make. The following will be the first members of the council :—Sir Hugh Bell, Bart. (chairman), Mr. R. Elliott Cooper, C.E., Dr. J. J. Dobbie, F.R.S., Mr. W. Duddell, F.R.S., Mr. E. B. Ellington, Sir Maurice FitzMaurice, C.M.G., Sir Archibald Geikie, K.C.B., P.R.S., Dr. R. T. Glazebrook, C.B., F.R.S., Sir Alfred Keogh, K.C.B., the Right Hon. Sir William Mather, Sir John Murray, K.C.B., F.R.S., Sir William Ramsay, K.C.B., F.R.S., the Right Hon. Sir Henry E. Roscoe, F.R.S., Sir William H. White, K.C.B., F.R.S. The secretary will be Captain H. G. Lyons, F.R.S., of the Science Museum.

WE record with regret the death, on January 4, at the age of eighty-five years, of Mr. B. Leigh Smith, prominent for his work in Arctic exploration. From *The Times* we learn that in 1880 Mr. Smith succeeded in reaching Franz Josef Land on its southern coast west of the region visited and discovered several years before by an Austrian expedition. He went out again in 1881. After surveying the coast up to Cape Lofley, his ship was crushed in the ice near Cape Flora, and he and his crew had to pass the winter under very trying conditions. In the following summer they managed to reach Novaya Zemlya in their boats, and were rescued by Sir Allen Young, in the *Hope*, sent out by a relief committee organised in England for the purpose, which received the support of the Government. His expedition added materially to the knowledge of the Franz Josef Archipelago. Mr. Smith, when in the *Diana*, rescued Nordenskjold's party, which had been frozen up in Spitsbergen. Mr. Smith continued to the end to take a keen interest in polar exploration. He was a fellow of the Royal Geographical Society, as well as of the Zoological and other societies.

ANOTHER polar explorer whose death we have to record is Captain F. H. Johansen, the companion of Dr. Nansen in his famous sledge journey across the north polar ice from the drifting *Fram*, and a member of the Amundsen Antarctic expedition. From an obituary notice in yesterday's *Times* we learn that Johansen was born at Skien, in Norway, in 1867, and matriculated at the university in 1886. In 1891–2 he went to the Military School, and became a supernumerary officer. He was so eager to take part in Nansen's expedition that, as no other post could be found for him, he accepted that of stoker. When the *Fram* drifted in the ice during 1893–4–5 to about 84° N., and Nansen decided to trust himself to a sledge and push his away over the moving ice as far north as possible, Johansen was selected to accompany his chief. After the return of the expedition to Norway, Johansen obtained Government employment. When the *Fram* was again fitted out to drift once more in the Arctic ice across the pole if possible, Johansen joined Captain Amundsen, and afterwards consented to accompany the ship to the south when Amundsen announced his change of purpose.

DR. R. M. FERGUSON, whose recent death at the age of eighty-three has deprived Edinburgh of one of her best-known citizens and educationists, was a skilled chemist and physicist. As a young man he had studied for several years in Germany under Bunsen and others, and although in later life much engrossed by his duties as headmaster in the Edinburgh Institution, he found time to work at his favourite subject of electricity. He published several papers on the telephone and on the action and theory of the induction coil in the Proceedings of the Royal Society of Edinburgh, and in the Transactions of the Royal Scottish Society of Arts, at the meetings of which he frequently exhibited experiments of an educational character. In 1867 he contributed an excellent book on electricity to "Chambers's Educational Series," and was also the author of the articles, "Electricity," "Galvanism," "Magnetism," &c., in the first edition of "Chambers's Encyclopædia." While preparing some scientific experiments for his classes in 1898 he met with a very serious accident, which left him lamed for life. He served for three terms of office on the Council of the Royal Society of Edinburgh, and was its representative on the Heriot Trust until about a year ago, when increasing frailty compelled him to resign. He was active in promoting the interests of the Edinburgh Mathematical Society, which, after the first few years of its existence, held (and still holds) its meetings in his school.

WE regret to see the announcement of the death of the veteran American astronomer, Mr. Lewis Swift, at the age of eighty-two. His enthusiasm for astronomy manifested itself at an early age; after working at business during the day he devoted his nights to studying the stars with the help of a small cheap telescope, a star atlas, and a single book, constructing his own primitive observatories at Marathon, N.Y., and afterwards at Rochester, in the same State. His first reward was the discovery of the comet of 1862 II., the elements of which are almost indentical with those of the August meteor shower. A little later he was provided with a 16-in. telescope by public subscription, and Mr. H. H. Warner built him an observatory. While at the Warner Observatory he discovered several comets and 900 nebulæ. Mr. Warner's failure compelled Swift to leave the observatory, and in 1894 he removed to a new one just erected on Echo Mountain, California, by Prof. Lowe. All the instruments were taken to the Lowe Observatory, where Swift, now assisted by his son, continued his work of discovering comets and nebulæ. He was compelled to leave the Lowe Observatory in 1901, and, his eyesight beginning to fail, was able to do little more astronomical work. He died at Marathon, New York, the scene of so many of his early struggles. Swift received three medals from the Vienna Academy, and several comet medals from the Astronomical Society of the Pacific. In 1881 the Paris Academy of Sciences awarded him the Lalande prize for his many discoveries, and in 1897 he was the first recipient of the Jackson Gwilt medal and gift from the Royal Astronomical Society, of which he had been a fellow since 1879.

AT the Northern Photographic Exhibition, which was opened in the Manchester City Art Gallery on January 3, a considerable amount of space has been devoted to a scientific section. The photographs in this section are divided into seven groups:—(1) Natural history; (2) radiograms; (3) photomicrographs; (4) geology, meteorology, and astronomy; (5) physics and chemistry; (6) photomechanical processes; (7) transparencies, in monochrome and colour. The natural history group includes birds, mammals, and insects of various kinds. An honourable mention is awarded to Mr. Alfred Taylor for a series of sixteen prints showing the life-history of the cuckoo from the egg to the age of migration (Nos. 17 and 18). Miss Frances Pitt shows six delightful animal studies —fox cubs, badgers, a rat, a cat, a hedgehog, and a spider. The radiograms of Drs. Bythell and Barclay and Dr. C. Thurston Holland are very striking and remarkably clear. Both are "honourably mentioned." The plaque is awarded to Dr. D. Hutchinson for two large frames showing twenty-eight stages in the development of the ovum of the Axolotl. An important contribution is that of Mr. W. F. A. Ermen, "The Rendering of Coloured Objects in Monochrome." He photographs clouds, flowers, a lady, &c., on an ordinary plate, and a Wratten panchromatic plate, with and without light filters. Dr. H. H. Hoffert has four sets of prints showing the effect produced when a heavy single discharge from a Leyden jar is allowed to pass over the surface of a photographic dry plate. This and the previous exhibit have both been awarded honourable mention. Messrs. G. R. Makin and J. W. Watkinson show autochrome photomicrographs of the various colour plate screens now on the market, and how the autochrome plate translates patches of single colours.

WE have received the annual report of Livingstone College for the year 1911–12, which shows that there is a deficiency on the ordinary funds of 700*l.* at the end of the financial year. The college is doing excellent work in training missionaries in the elements of medicine, and an earnest appeal is made for funds to further this object.

The South African Journal of Science for November (vol ix., No. 4, 1912) contains a summary by Mr. John Muller on the practical medico-legal use in South Africa of the "precipitin" test for the recognition of bloodstains and of what animal's blood they consist. In a number of criminal cases the test has proved of the greatest value.

IN *The Quarterly Journal of Experimental Physiology* (vol v., No. 4), Mr. A. J. Clark describes experiments on the destruction of alkaloids by the body tissues. He finds that the livers of the frog and rabbit possess the power of destroying atropine, and that this power persists when all living cells are destroyed, and is due to a soluble substance resembling a ferment in its action. In the frog the heart and kidneys, and in the rabbit the blood, have a similar but less marked power, but no other tissues have any such power. In the cat, rat, and dog none of the tissues has any such power.

THE Selborne Society is to be congratulated on a marked increase in its membership during the past year. According to an editorial note in *The Selborne Magazine* for January, it has been decided to divide the society into sections, an arrangement which it is expected will increase the output of special work.

To the wet summer of 1912 is attributed a falling off in the number of persons attending the excursions of the Clifton College Scientific Society, the report of which for 1911–12 is to hand. This, however, forms no sufficient excuse for the small competition for the Joshua Saunders prize, which was awarded for an essay on the local distribution of newts.

IN the Report of the Indian Museum, Calcutta, for 1911–12, reference is made to the opening of the art galleries during the visit of their Majesties the King and Queen, and also to the temporary housing of the Victoria Memorial Exhibition within the building. A considerable falling off in the number of visitors during the year under review is tentatively attributed to the closing of the museum on several occasions.

VOL. viii., part 31, of *Spolia Zeylanica* is devoted to the first part of "A Guide to the Collections of the Colombo Museum," this section dealing with archæology and ethnology. It is illustrated with forty-four well-executed plates of objects of special interest. Among these attention may be directed to sculptures (plate i.) and designs on flags (plate xx.), which appear undoubtedly to represent lions, some of the former dating from about 320 B.C. (p. 167). As most if not all of the other animals represented in native Sinhalese art are indigenous to the island, the question naturally arises as to the source of the concept of the lion. In former times lions were found over central and north-western India, but there appears to be no record of their occurrence further to the south on the mainland, let alone in Ceylon. No allusion to this interesting point is made by Dr. J. Pearson, the author of the guide.

THE current number of *The Quarterly Journal of Microscopical Science* contains no fewer than three papers on the experimental hybridisation of Echinoderms, by Prof. Macbride, Dr. G. Debaisieux, and Dr. Cresswell Shearer, Mr. W. de Morgan and Mr. H. M. Fuchs. Many memoirs have appeared on this subject during the past few years, and perhaps the most remarkable thing about them is the startling want of harmony between the results obtained by different observers, and even by the same observer at different times. It is evident that as yet we know very little of the factors which determine in what proportion maternal and paternal characters will be transmitted to the hybrid offspring. Careful and accurate observations, such as those recorded by the workers above mentioned, can scarcely fail, however, in the long run, to throw much light upon this extremely difficult problem.

A TIMELY paper on foot-and-mouth disease has been published by Prof. Bang, of Copenhagen, in the Journal of the Board of Agriculture (No. 8). This disease affects ruminants and pigs, and occasionally also man; it is characterised by the formation of vesicles in the mouth and occasionally on the lips, snout, and nostrils, and on the skin round the hoofs. These are very painful, so that the animal is unwilling either to walk or to eat. Whatever the causative agent, it is very minute, it exists in the matter contained in the vesicles, and it passes through the pores of a filter; a very small amount, even 1/5000 c.c. of the contents of a vesicle, is sufficient to cause the disease. To young animals the disease is generally fatal, but adult animals often recover; the loss, however, is so serious that even the most drastic action is justified in coping with it. Prof. Bang looks forward with some uncertainty to the immediate future, but thinks that the situation is tolerably well in hand.

THE composition of buffalo milk in India has been investigated by Messrs. Meggitt and Mann, and the results are published in No. 4 of the Chemical Memoirs of the Pusa Research Institute. The percentage of fat is remarkably high, being 8 per cent. in place of the 3 per cent. found in cow's milk; the percentage of total solids is also high, rising to 18 or even 20 per cent., an amount higher than is found in some of our fruits and vegetables. The effect of changes of conditions on the composition of the milk could not be fully investigated, but so far as the work went it indicated that they are of the same character as in the case of cows.

An interesting instance of the effect of caponising an ostrich is described by Mr. Fitzsimons, director of the Port Elizabeth Museum, in the Agricultural Journal of the Union of South Africa (No. 3, 1912). The ovaries were removed from three hen ostriches four years of age. Shortly afterwards the birds began to lose their characteristic female appearance and to take on the external characters of the male; the body feathers no longer remained drab-coloured, but assumed the glossy jet-black colour of the cock bird, while the wing and tail feathers were so completely transformed in every detail that feather experts to whom they were shown declared them to be typical cock feathers. One of the birds was killed, and is mounted in the Port Elizabeth Museum.

"THOUGHT as the mainspring of development" forms the subject of a powerful article by Prof. C. J. Patten, of Sheffield, translated into German by Dr. W. Breitenbach, and published in the *Neue Weltanschauung* (vol. iv.).

IN the Transactions of the American Mathematical Society (xiii., 4), Mr. Wm. H. Roever discusses the southerly and easterly deviations of falling bodies for an unsymmetrical field of gravitational force, this problem referring to cases where, owing to the attraction exerted by mountain ranges, the ordinary formula becomes inapplicable.

UNDER the title, "Rising Prices and the Public," Prof. John Bauer, writing in *The Popular Science Monthly* for December, 1912, discusses an economical problem which has recently assumed practical importance. His general conclusions are to the effect that the evils which result are not due to high prices so much as to increases in prices which affect incomes of some classes more rapidly than others. The social effects are to foster speculation at the expense of industry by penalising the cautious investor whose "safe" income has depreciated in value; further high prices lead to increased extravagance and luxury. He considers that for the public at large everything should be done to prevent considerable changes, either upward or downward, in the price level.

A PLEA for the more general cultivation of "nature-study" is contained in an article in *Symons's Meteorological Magazine* for December on phenological observations, by Mr. R. H. Hooker. The records collected under the auspices of the Royal Meteorological Society are of a simple character, and "aim more directly at a knowledge of the effect of the weather upon the commonest plants, birds, and insects, and at obtaining some measure of the lateness or earliness of the season." For many years such observations were collected and analysed by the Rev. T. A. Preston, of Marlborough, and more recently, in a reduced form, by Mr. E. Mawley, of Berkhamsted. The Royal Meteorological Society undertakes to send forms and instructions to anyone willing to assist in the work. At present only parts of the south of England can be said to be fairly represented; observations in Scotland, the north of England, and in Ireland are very scanty. As one instance of the practical utility of similar observations, reference is made to the recent investigation by Dr. Unstead, who, from the dates of sowing and harvesting wheat, in combination with data as to temperature, was able to indicate, *inter alia*, the regions in Canada where any attempt at wheat-growing would be foredoomed to failure.

THE recent disastrous storms and high seas in the English Channel and the North Atlantic, together with the serious damage to the P. and O. liner *Narrung* and other large vessels, have directed attention to the heights of waves. The chief officer of the above vessel estimated that the wave that caused the principal damage was 70 ft. high. Admiral FitzRoy ("Weather Book," 1863, p. 388) quotes a case experienced by himself near the Bay of Biscay in which the waves were not less than 60 ft. high. He says: "I never saw such seas before, and have never seen any equal to them since, either off Cape Horn or the Cape of Good Hope, during two circumnavigations, and many years of foreign service." This case is referred to in an article on ocean waves in the Meteorological Office Chart of the Indian Ocean for January, 1913, and several other trustworthy reports of extraordinary waves are quoted. Among these we may mention (1) one by Captain David, R.D., R.M.S. *Corinthic*, about 45° S., 102° E., estimated to be 50 ft.; (2) Captain Kiddle, ss. *Celtic*, determined a height of 70 ft. for several waves in mid-Atlantic from good measurements. The late Admiral Sir W. J. L. Wharton (formerly hydrographer to the Navy) expressed the opinion that seas of 40 to 90 ft. in height may be experienced, albeit the most probable maximum is 50 or 60 ft.

THE November number of *Le Radium* contains a memoir by M. A. Zaroubine on the ionisation currents produced in a solid dielectric by the gamma rays from radium. A sheet, two millimètres thick, of the hard paraffin known as ozokerite was placed between aluminium electrodes to which differences of potential up to 2200 volts could be applied. The gamma rays entered the dielectric through one of the electrodes, and the currents produced were measured by means of a Dolezalek electrometer. Up to 2000 volts they follow Ohm's law. If the dielectric is first ionised, the radium removed, and the electric field then applied, the current falls off with time according to a hyperbolic law. The law of superposition of effects due to several causes does not apply to the ionisation currents. Under the action of the radiation the dielectric develops an electromotive force which is capable of producing a current analogous to that of polarisation.

HALF the December 22 number of the *Naturwissenschaftliche Wochenschrift* is devoted to an article by Prof. Valentiner on new facts in physics. More than a dozen important advances are described in clear and simple language, which would be readily understood by those whose work lay outside the particular fields selected for description. Most of the advances which receive notice have been mentioned in these notes, but there are two which have not, and which deserve attention. Messrs. Reboul and De Bollement have found that copper and silver at 500° C. eject particles in a vacuum in oxygen, air, and carbonic acid, which form deposits on the walls of the containing vessel. In hydrogen no deposit occurs. Prof. Wiener has directed attention to the possibility of protecting balloons from lightning by replacing the cord netting now in use by netting containing wire, so that the balloon is virtually in a wire Faraday cage. He has also suggested the insertion in the gas valves of the Davy lamp arrangement of fine copper wire netting so as to protect the gas inside the balloon from the effects of electric sparks outside.

AN interesting contribution to the study of the stereoisomerism of the oximes is contained in a paper by Mr. F. Carlo Palazzo on trichloroacetaldoxime (*Atti R. Accad. Lincei*, vol. xxi., ii., 530). Hitherto only one oxime, melting at 39–40°, has been obtainable from chloral, but it is now shown that this substance probably consists of a mixture of two stereoisomerides, as with water it gives what is apparently a mixture of the corresponding stereoisomeric oximino-acetic acids, one of which is readily decomposed further by alkalies, giving hydrogen cyanide, whilst the other forms a stable alkali salt. These changes are easily interpreted by writing them as follows:—

$$\text{I.}\quad \begin{array}{c}\mathrm{H.C.CCl_3}\\ \|\\ \mathrm{OH.N}\end{array} \longrightarrow \begin{array}{c}\mathrm{H.C.CO.OH}\\ \|\\ \mathrm{OH.N}\end{array} \longrightarrow \mathrm{H_2O + CO_2 + H_2O}$$

$$\text{II.}\quad \begin{array}{c}\mathrm{H.C.CCl_3}\\ \|\\ \mathrm{N.OH}\end{array} \longrightarrow \begin{array}{c}\mathrm{H.C.CO.OH}\\ \|\\ \mathrm{N.OH}\end{array} \longrightarrow \text{stable salt.}$$

The view that the trichloroaldoxime, melting at 39°, is really a mixture is confirmed by the fact that it can be obtained with a considerably higher melting point, viz. 56°, when carefully freed from its syrupy congener, although it is still doubtful whether this material represents a definite individual.

The Engineer for January 3 says that there is no hesitation and temporising about the report which Sir Francis Fox has presented to the Dean and Chapter of St. Paul's Cathedral. Sir Francis states that the cathedral is overloaded, and is actually moving and cracking; the eight great piers supporting the dome have moved, and have sunk from 4 to 6 in. It is to be hoped that this report will settle once and for all questions affecting the injury that is to be anticipated from subterranean work in the neighbourhood of the cathedral. *The Builder* of the same date, commenting on this subject, says that, in view of the report, the abandonment of the London County Council proposal to construct a tram subway in the immediate vicinity of the fabric is practically assured; in face of such a report it would be folly to proceed.

AN interesting article in *Engineering* for January 3 on the Daimler motor-omnibus gives some account of the process of elimination whereby the present highly efficient motor-omnibus has been produced. In this process of natural selection, the police authorities gave very great assistance by avoiding the institution of any initial standard of perfection, and gradually increasing their requirements as experience was gained. The forward drives on the present omnibus are either direct or through chains, spur-gearing being used solely for the reverse. This plan is in consequence of the pressure of the London police authorities, who insisted that the omnibus should run as silently on low gear as on high. Helical wheels were tried, but failed to satisfy the demands of the authorities. In desperation almost, chain drives were installed, though the makers of the chains declared that they did not think that they would last a week, since not only was the pressure transmitted high, but the chain speed exceeded 2000 ft. per minute. As the event has proved, however, these prognostications were falsified, the chains giving a very satisfactory service. The chain pinions are of high-carbon steel, unhardened; the spur-gears used for the reverse are of nickel-chrome steel, case-hardened.

OUR ASTRONOMICAL COLUMN.

THE ATTRACTION OF SUN-SPOTS FOR PROMINENCES.—In an illustrated article appearing in No. 4, vol. xxxvi., of *The Astrophysical Journal*, Dr. Slocum shows that in some cases sun-spots apparently have a very strong attraction for prominences. He deals especially with a large group of spots which first crossed the solar disc between August 2 and 15, 1910, and received the Greenwich number 6874; at the next apparition it was numbered 6880, and, reappearing on September 27, as an extended group, its parts were numbered 6894 and 6893.

At each apparition active prominences and large flocculic areas were observed in the immediate neighbourhood of the spot, the best prominence displays occurring at the west limb on October 8, and at the east limb on October 22. Photographs, in calcium light, taken on the former date, show that the prominences were pouring down from both sides right into the large spot. So many jets are visible that there can apparently be no doubt as to their common direction; moreover, the measures of successive photographs indicate accelerated velocities for the matter forming these jets. Three bright knots, shown on photographs taken at 4h. 26·6m. and 4h. 34·9m., respectively, show velocities along the apparent trajectories of 16, 20, and 60 km. per second at distances of 170,000, 130,000, and 75,000 km. from the centre of attraction; other points recognised on two photographs give velocities ranging from 15 to 90 km. per second. In addition to the general feature of attraction there is also evidence of repulsion, but the jets showing this are very short-lived.

The distances over which the attractive force of the spot appeared to exert its influence are remarkable. The prominences covered 45° of the solar limb, and prominences 260,000 km. (162,500 miles) from the spot were evidently drawn towards it.

Both Hale and Evershed have previously found evidence for this spot attraction, but Dr. Slocum's observation differs from theirs inasmuch as he finds accelerated velocities for the prominence matter, whereas their observations indicated diminishing velocities.

THE NEXT RETURN OF ENCKE'S COMET.—In a communication to M. Flammarion, Mr. F. E. Seagrave gives the results of his calculations concerning the return of Encke's comet in 1914. From the elements, corrected for the Jovian perturbations, it is seen that perihelion passage should take place on December 5.89, 1914, while the ephemeris shows that the comet should be circumpolar and near to the earth about October 27, 1914; on this date its distance from us will be about 42 million kilometres (26·2 million miles), and the comet should be of about the fourth magnitude. The period found by Mr. Seagrave is 1204·8001 days. (*L'Astronomie*, December.)

THE MAGNITUDE AND COLOUR OF BROOKS'S COMET, 1911*c*.—In a note appearing in No. 4619 of the *Astronomische Nachrichten*, Herr Max Valier gives the magnitudes, diameters, and colours of Brooks's comet (1911*c*), as observed by him during the period September 7 to November 4, 1911. Both magnitudes and colours were regularly progressive until October 21, the former going from 5·0 to 1·8, the latter from bluish, through blue, greenish, greenish-yellow, yellowish-red, to white; the order was then reversed in both cases.

JOHN GOODRICKE.—A portrait of John Goodricke, the astronomer who discovered the periodicity of Algol in 1783, and suggested the accepted explanation of the star's variability, has recently been presented to the Royal Astronomical Society by Mr. C. A. Goodricke, of Hampstead. It is not generally known that John Goodricke was deaf and dumb from birth, yet, although he died in 1786, at the early age of twenty-two, his scientific attainments had earned for him the fellowship of the Royal Society and the award of the Copley medal; his astronomical work was done at York. An interesting letter, giving the chief facts concerning Goodricke's life, appears in No. 1, vol. lxxiii., of *The Monthly Notices*.

"THE COMPANION TO THE OBSERVATORY."—This useful annual, for 1913, contains practically the same matter as last year, with the various tables revised. Messrs. Denning and Lewis have revised the "Meteor Showers" and "Double Stars" sections respectively, and a welcome addition is a list of the principal star clusters and nebulæ. It is interesting to note, from the page dealing with the universal time system, that every State of any importance, except Russia, now uses a standard time directly depending upon the Greenwich meridian; Russian time depends upon the Pulkowa meridian, and is 2h. 1m. fast on Greenwich. We remark that the editorship of *The Observatory* has changed hands, the new editors being Mr. F. J. M. Stratton, of Cambridge, and Mr. A. S. Eddington and Dr. S. Chapman, of Greenwich, in place of Messrs. T. Lewis and H. P. Hollis. The "Companion" is published by Taylor and Francis at 1s. 6d., and should be in the hands of every astronomical observer.

DEVELOPMENTS OF NATIONAL EDUCATION.

THE papers read at the North of England Education Conference, at Nottingham, on January 2, 3, and 4, give evidence of a growing realisation of the principal weaknesses of English public education. One of the most remarkable and significant developments in national education, and one to which considerable prominence was given in papers read by the Rev. W. Temple, headmaster of Repton School, and Mr. P. E. Matheson, New College, Oxford, respectively, is the valuable work of university level being done by the Workers' Educational Association. Mr. Temple stated that there are now more than 100 university tutorial classes in different parts of the country, with nearly 3000 students, which have been organised and provided by this association. These classes are limited to thirty students, who undertake to attend throughout a three-years' course. The class meets once a week for twenty-four weeks during the winter session. Each student writes an essay once a fortnight. The essays are pronounced by distinguished scholars to be equal in value to the work done in Oxford by men who take a first class in the honours history school. Mr. Temple concludes from the experience of the association, that "not only is a vast amount of intellectual capacity going to waste in England at this moment for lack of opportunity," but "that men who have only had an elementary education and no secondary can none the less do work of a university type at the proper age. Of course, they have not the *knowledge* . . . but apparently their intellectual capacity has gone on growing."

The advantages of practical and manual work of various types in elementary schools were frequently insisted upon. Mr. Bird, superintendent of handicraft, Leicester Education Committee, criticised effectively the defects of the present methods of manual training in schools, in which so much stress is laid upon mere copying of models, and so little attention given to developing the ingenuity and originality of the boys. A suggestive criticism was made by Mrs. Ogilvie Gordon in a paper on "trade schools" upon the much-quoted Continuation Trade Schools of Munich. She stated that "a weak point in the Munich system, and in most of the Continental systems, is that there is no easy bridge by which the public elementary and trade continuation class scholar can pass into the higher ranks of his vocation and complete his studies in the polytechnic or university. The avenue to these higher courses is solely through the gymnasial high schools."

Sir William Mather, in a weighty and important paper on the cooperation of employers and education authorities, complained "of the want of aptitude and intelligence, application and interest, displayed by a considerable majority of the boys and girls coming to work direct from the elementary schools." From his experience as an employer who had for some years made attendance at evening continuation schools compulsory upon his junior employees, he strongly urged a similar course of action upon all employers of labour. In a paper upon the educational responsibilities of the employer, Councillor George Cadbury, jun., described the remarkably complete scheme of continued education (mental and physical) in operation at the Bournville Works for the junior employees. The main features of the scheme are (1) compulsory attendance at evening continuation school, with remission of fees, and the award of prizes; (2) physical exercises and swimming during the firm's time; (3) special technical and commercial classes within the works during working hours.

J. WILSON.

THE INHERITANCE OF FECUNDITY IN FOWLS.[1]

THE application of Mendelian principles to the inheritance of an economically productive character of an animal has a twofold importance, viz. first, because it may be questioned whether or not it is possible to apply a Mendelian interpretation to the facts, and, secondly, the data and conclusions arrived at make it possible for others to outline a practical scheme of breeding with the view of an increased egg-production.

In the study before us, Mr. Raymond Pearl, an investigator well known by his work on the fecundity and breeding of fowls, sets forth in great detail the

[1] "The Mode of Inheritance of Fecundity in the Domestic Fowl." By Raymond Pearl, *Journ. Exp. Zool.*, 1912, pp. 153–268.

results of five years' work which has involved thirteen generations and several thousand individuals. Two very definite results have been obtained, and it is important that these should be grasped at the outset, viz.: (1) that the record of egg-production of a hen is not of itself a criterion of any value whatsoever from which to predict the probable egg-production of her female progeny—in short, there is no correlation between the egg-production of individuals and either their ancestors or their progeny; (2) notwithstanding the above-mentioned fact, fecundity is, in some manner or other, inherited in the domestic fowl.

The mere fact that a fowl is anatomically normal is not sufficient to ensure the laying of eggs; two physiological factors or groups of factors are essential. The first of these is termed the "normal ovulation" factor, *i.e.* the complex physiological characters which in their entirety determine the normal reproductive activity and definite periods of productivity, what are termed the winter and summer cycles, depending upon differences in the complex physiological mechanism concerned with the maturation of the oocytes and ovulation.

Winter egg-production is chosen as the basis of measure, representing as it does the cycle in which the widest difference is found between birds of high and low fecundity. Three well-defined classes are apparent; these include birds with high winter records, those with low, and those that do not lay at all. In respect to these three divisions there is a definite segregation in the Mendelian sense.

As the result of considerable work supported by a mass of evidence, the author concludes:—

There are three distinct and separately inherited factors upon which fecundity in the female fowl depends.

The first of these factors (which may be called the anatomical) determines the presence of an ovary, the primary organ of the female sex. The letter F is used throughout to denote the presence of this factor.

There are two physiological factors. The first of these (denoted by L_1) is the basic physiological factor, which, when present alone in a zygote with F, brings about a low degree of fecundity (winter record under thirty eggs). This factor is under no limitations in gametogenesis, but may be carried in any gamete, regardless of what other factors may be also present.

The second physiological factor (denoted by L_2), when present in a zygote together with F and L_1, leads to a *high* degree of fecundity (winter record more than thirty eggs). When L_1 is absent, however, and L_2 is present, the zygote exhibits the same general degree of fecundity (under thirty) which it would if L_1 were present alone. These two independent factors, L_1 and L_2, must be present together to cause high fecundity, either of them alone, whether present in one or two "doses," causing the same degree of low fecundity.

The second physiological factor, L_2, behaves as a sex-limited (sex-correlated or sex-linked) character, in gametogenesis, according to the following rule: the factor L_2 is never borne in any gamete which also carries F. That is to say, all females which bear L_2 are heterozygous with reference to it. Any female may be either homozygous or heterozygous with respect to L_1. Any male may be either homozygous or heterozygous with reference to either L_1, L_2, or both.

Numerous other matters of great interest are lucidly set forth, to which want of space forbids us to refer. The whole piece of work is an excellent example of the practical application of Mendelian principles to an important economic question, and deserves most careful study.

WALTER E. COLLINGE.

EGYPTIAN SODA.

A REPORT by Mr. A. Lucas on "Natural Soda Deposits in Egypt" has been issued by the Ministry of Finance as "Survey Department Paper. No. 22." Natural soda occurs in Egypt principally in the Wadi Natrun in the Libyan desert, but it is also found some fifty kilometres due north of this, at El Barnugi, in Lower Egypt, and at Mahamid, in Upper Egypt. The principal soda-lakes are in a valley the bottom of which is about 27 metres below sea-level; the lakes extend over a range of 30 kilometres, the nearest being about 38 kilometres from the Nile. In ancient times there were two lakes, which became united when water was most abundant, but at the present time they are divided into about a dozen separate areas, the smaller of which dry up almost entirely in summer, leaving only a few pools of water. The soda is found in solution in the water of the lakes, in a solid form at the bottom of some of the lakes and as an incrustation on the adjoining ground.

Analyses of the water are given for ten of the twelve lakes. In the case of the most concentrated the figures were:—Specific gravity, 1·260; Na_2CO_3, 62·15; NaCl 252·35; Na_2SO_4, 64·54; total 379·04 grams per litre. The lakes are largely fed by springs in the bed of the lakes, but also by water trickling in from the surrounding ground. At low water one of the springs is so powerful that a boat trying to pass over it is driven forcibly back; another spring, round which an iron cylinder had been placed, was found to be flowing at a height of 80 centimetres above the lake level at the end of February. These springs flow energetically all the year round, but in one case at least there is increased activity about October. Analyses of the spring and well water showed total solids ranging from 0·3 to 4·6 grams per litre, the quantity of soda ranging from 0·2 to 1·2 grams per litre, almost all in the form of bicarbonate; it is therefore probable that the soda is carried into the lakes by the inflowing water, and is there concentrated by evaporation.

The water-level in the lakes falls in summer, begins to rise again in October, and reaches a maximum in March. This variation might be attributed to the different rates of evaporation in summer and in winter; but there appears to be a definite increase of flow in October; this precedes the slight autumn rains, and must be due to an increased flow of underground water. The underground flow is from the north-east, in which direction the Nile lies nearest; this is also the side on which the visible flow into the lakes takes place. The fact that the lakes fall whilst the Nile is rising, and conversely, may be due to lag; in the case of some wells in the neighbourhood of Cairo, under constant observation for thirteen years, the time required for the water-levels to be raised by the influence of the Nile flood varied from 25 to 55 metres per day.

The lakes deposit both salt and soda. The former is practically pure, at least after washing; the latter consists mainly of the compound

$$Na_2CO_3,NaHCO_3,2H_2O,$$

but may contain an excess either of carbonate or of bicarbonate; it is often mixed with large quantities of salt (from 2 to 27 per cent.), and of sodium sulphate (from 0 to 39 per cent.).

The salt is probably of marine origin. The large excess of sulphate and the absence of iodides and bromides may be explained by the separation of gypsum and of salt on partial evaporation, and the subsequent washing away of the mother-liquors, *e.g.* by a fresh influx of sea water. The conversion of chloride and sulphate into carbonate and bicarbonate has been explained as due to a reversal of the usual interactions of these substances with calcium and magnesium carbonates, *e.g.*

$$2NaCl + CaCO_3 \rightleftharpoons Na_2CO_3 + CaCl_2$$
$$2NaCl + CaCO_3 + CO_2 + H_2O \rightleftharpoons 2NaHCO_3 + CaCl_2$$
$$Na_2SO_4 + CaCO_3 \rightleftharpoons Na_2CO_3 + CaSO_4,$$

but it is not easy to understand how such interchanges could result in the production of more than a mere trace of the alkali. A more probable explanation assumes as the first stage a reduction of sulphate to sulphide by organic matter, living or dead, with a subsequent displacement of sulphuretted hydrogen by carbonic acid:—

$$Na_2SO_4 - 4O = Na_2S,$$
$$Na_2S + CO_2 + H_2O = Na_2CO_3 + H_2S, \text{ \&c.}$$

In support of this view there are quoted statements by Lunge that the springs "are full of algæ," that "at a distance of three feet from their origin they begin to give off sulphuretted hydrogen," and that the "odour becomes more intense a little further on, but ceases at a greater distance."

The Wadi Natrun deposits were probably the oldest known occurrence of natural soda in the world, and they constituted the principal source of supply of that commodity for thousands of years. They are at present worked by the Egyptian Salt and Soda Company, who took them over from the Société Anonyme des Soudes naturelles d'Egypte, to which latter company the Government had granted at the end of 1897 a concession for fifty years. The company makes caustic soda and soda ash, and, in addition, extract and sell both natrun (raw soda) and salt. According to the customs returns the exports include 1200 tons of caustic soda, value about 10,000*l.*, and about 800 tons of natrun. But both these products are sold also for use in the country, and the company uses considerable quantities of caustic soda at its own soap factory.

The Wadi Natrun is connected with the State railway system by means of a narrow-gauge railway 50 kilometres long, running from Khatatba to the centre of the Wadi. T. M. L.

AGRICULTURE IN INDIA.

THE Agricultural Journal of India (vol. vii., part iv.) contains several articles which testify to the assiduity with which various questions are being investigated. Dr. C. A. Barber contributes a paper on seedling canes in India, and gives a brief outline of the chief phases in the cane-sugar industry and the causes which led to the raising of seedling canes in Java and Barbados. Similar work has been carried out in India, and records are being accumulated, in order to afford data for a general classification of the canes of the country. Difficulty was experienced in procuring sugar-cane arrows with a fair proportion of anthers containing fully matured pollen; in fact, the only native cane possessing this property was the Cheni of Mysore.

Mr. C. E. Low writes on the supply of agricultural cattle in India, and after giving statistical information and a description of the present situation regarding cattle supply, with an examination of the various features involved, discusses the question of the food supply in times of famine and the measures which the Government is adopting to cope with various causes which tend to a diminution in the number or efficiency of agricultural cattle. It is interesting to note, in connection with the storage of fodder as reserves for seasons of famine, that "the main objection to this proposal in the popular mind seems to be that the possession of stored fodder tempts a hostile neighbour to revenge himself by setting light to the stack."

Messrs. E. J. Woodhouse and T. Bainbrigge Fletcher report the adoption of systematic hand-picking of the caterpillars of *Agrotis ypsilon*, and the use of the Andres Maire moth-trap in the Mokameh Tal. During the season of 1911 upwards of 60,000 caterpillars were hand-picked, and 2000 Agrotis moths were caught in November by one trap. It is estimated that by the above means 6000 acres of crops were saved.

Mr. F. M. Howlett discusses the possibility of the introduction of yellow fever consequent on the opening of the Panama Canal and the shortened route from the fever-zone in the West Indies and Central America. It is pointed out that, if yellow fever were introduced, and *Stegomyia fasciata* proved to be the only effective carrier, the disease would be more or less confined to the coast districts and seaport towns, while if *S. scutellaris* also proved effective, there is no reason why it should not spread infection throughout the country. The distribution of the different species of Stegomyia in the larger seaports is now being ascertained by means of a systematic survey.

NATURAL SCIENCE PAPERS AND MEMOIRS.

IN the sixth volume of *Fortschritte der naturwissenschaftlichen Forschung*, Prof. W. Halbfass reviews the recent work on the topography, hydrography, and geology of the lakes of Asia, Africa, America, and Australia. Dr. A. Ruhl, in his paper on a new method in geomorphology, pleads for the application of the deductive method to the borderland between topographical geology and geography. The exposition of the peneplain theory of Prof. Davis, as well as of other points bearing on normal marine, glacial, and arid cycles, is illustrated by photographs and diagrams. The results of recent researches in radio-activity, particularly on uranium, thorium, and actinium, form the subject of a review by Prof. Otto Hahn and Dr. L. Meitner.

In the same volume the classification of functional mental disorders, and the existence of fundamental differences between organic and functional psychoses, are discussed by Prof. O. Bumke. The problem of regeneration, in its inorganic, botanical, and zoological aspects, is surveyed by Prof. D. Barfurth, who appends to his memoir a selected bibliography containing about 500 references. After examining the various theories of regeneration, he regards that of Roux as being most nearly in accord with the facts observed, *i.e.* that, in cases where regeneration can take place, disturbance of the living organism in an adult individual gives rise to formative stimuli in the reserve germ-plasm of the adult cells or of cells not yet fully differentiated, which lead to the re-establishment of the organism as a whole. Dr. W. Hausmann, in a paper on optical "sensibilisators" in plants and animals, concludes that several pigments which occur commonly in nature are photo-biological "sensibilisators," which react under definite physiological and pathological conditions.

Dr. W. G. van Name (in Proc. Boston Soc. Nat. Hist., vol. xxxiv., pp. 413–619, plates 43–73) gives an account of the simple Ascidians of the region from the Gulf of St. Lawrence to Long Island Sound. This coast is not rich either in number of species of Ascidians or in those presenting striking structural characters. Leaving out of account all uncertain forms, thirty-four species (seven of which are new) are recorded. The genus Bostrichobranchus, known only from the Atlantic coast of North America, is the most interesting Ascidian described in this memoir. Dr. van Name regards this as the most highly specialised genus of Ascidians, and as having been derived from the genus Eugyra.

RADIATIONS OLD AND NEW.[1]

THE remarkable properties of the rays from radio-active substances which have been examined with such eagerness in recent years throw a curious and interesting light on the older attempts to find a satisfactory theory of radiation. Newton and Huygens, Young and Fresnel, and other thinkers down to our own times have discussed various hypotheses, rejecting, adopting, or amending, and each has given his reasons for his final choice. It is instructive at the present time to examine some of those reasons, and to consider the influences which prompted them to make their great discoveries. More particularly is this the case because some expressed their ideas in the language of a corpuscular theory, and we have now had for some time the opportunity of examining radiations which we know to be corpuscular.

Let me first of all set out some of the facts of the new radiations. Thanks to the recent beautiful experiments of Mr. C. T. R. Wilson, I am able to illustrate my statement by a method which would have been beyond my power even a few months ago. We have been for some years laboriously investigating the paths of the α, β, and γ rays through gases and other material substances. Our work has been conducted in the dark, so to speak, for we have been obliged to rely mainly on electrical methods, to feel our way along those paths in some cases, and in others to arrive at their form by indirect reasoning. Mr. Wilson has shown us how to obtain a clear photographic representation of the whole path of an α or β ray. The ocular demonstration is helpful from a scientific point of view, not only because of the confirmation which it has given of the work we have already done, but also because of its suggestiveness for the future. It is, if I may say so, invaluable from a lecturer's point of view, because it enables me to dispense with difficult explanations of the methods by which recent advances have been made, and to show you, on the screen, direct illustrations of the main points that I wish to emphasise.

FIG. 1.—α-Rays from radium. Some of the α-particles have traversed the air before the expansion, others after the expansion.

The α ray is, as is well known, an atom of helium projected by the exploding radio-active atom with a speed of some ten or twenty thousand miles a second. Although it moves off at this excessive rate it is able to penetrate only two or three inches of air in its ordinary state, or one or two thousandths of an inch of heavier substances, like aluminium or gold. When it comes to the end of its range, it has spent practically the whole of its energy, it has lost its distinction, and sinks to the level of an atom moving with ordinary speed. Some years ago I showed that it moved in an almost perfectly straight line from start to finish; and it then became evident that on its way through a gas or a metal or any other substance it passed through every atom which it met. It does not push them out of its way, for it meets hundreds of thousands of atoms, each one, as a rule, far heavier than itself; and it does not thread its way between them, for it has no intelligence, and cannot recover a line once lost. In 1907 it was shown by Mr. Geiger, working at Manchester, that the track of the α particle was not absolutely straight, but that the particle was liable to slight deflections, especially when near the end of its path.

On the screen there is now one of Mr. Wilson's photographs of the tracks of α particles radiating from a minute speck of radium (Fig. 1). You will see how straight they are for the most part, and yet a closer examination will show slight, very sudden, deflections.

The next slide is an enlargement of two tracks, one of which shows the deflections very well (Fig. 2).

FIG. 2 — α-Rays from radium.

It is difficult to realise that we are looking at a picture of the path of a single atom through the air, recorded by its own efforts; and we may well ask how Mr. Wilson has managed to obtain so wonderful a result. As a matter of fact his method is an improvement on one which he had used and explained some years ago, but it will be well to describe it briefly once more. A short glass cylinder of about six inches in diameter—its outline can be seen in Fig. 1—is closed at one end by a glass plate; at the other end is a movable piston. The chamber is filled with moist air, which is chilled if the chamber is suddenly enlarged by the withdrawal of the piston. A fog is then formed, which settles in the first place on any "ions" which may be present. In the track of α and β rays there are trails of ions formed by the rays. It is only necessary therefore to illuminate the fog, and to photograph it, and we have such a picture as that on the screen.

The picture confirms so far as it goes the main conclusions we had already drawn as to the path of the α ray. On the screen is now a copy of a drawing which I made a year or two ago to show the various forms of the path as we then pictured them to our-

[1] Evening discourse delivered on September 6 before the British Association at Dundee by Prof. W. H. Bragg, F.R.S.

selves (Fig. 3). The paths, it should be explained, are shown starting parallel from a common line instead of radiating from a point. Mr. Wilson's picture shows that I have somewhat exaggerated the deflections to which I wished to direct attention; but otherwise the agreement is satisfactory.

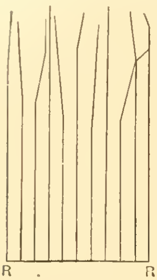

Fig. 3.

The results which I would emphasise are these, that an atom of helium can and does sometimes move at a rate comparable with that of light, and when endowed with that speed can penetrate other atoms with ease.

Before leaving the α ray, there is one other point I should like to mention. If we consider how it can be that deflections of the α particle are so rare, and yet so sharp, we find ourselves driven to consider with Rutherford that the deflection is due to a force exerted from a very small centre or central core within the atom, backed by all the mass of the atom. It is only when the flying α particle tries to pass very close to this centre that a noticeable deflection is produced. We may picture to ourselves the electrons belonging to the atom as revolving about this central core, which we must then take to be electrically positive, just as the planets move about the sun. When an α or β particle penetrates an atom and is deflected it is the central core that is in the main responsible; electron satellites are of no account. A rough analogy is to be found in the motion of a comet through the solar system.

Fig. 4.—A complete α-ray from radium emanation.

When a deflection takes place we may expect a recoil of the atom in which it occurs. In some of the illustrations you will observe that there is a slight enlargement of the track at its beginning (Fig. 4). This may well be the recoil of the radio-active atom from which the α particle has been ejected. We have for some time been familiar with this recoil effect, which has been made the basis of certain important electrical methods of radio-active investigation. It is very interesting to see a well-marked little spur on one of the α ray tracks in Fig. 2, just where we should expect to find the effects of an atom of oxygen or nitrogen recoiling from its effort to turn the helium atom out of its path.

A β ray does not leave such an obvious track. It is the single electron moving with velocity very closely approaching in some cases to that of light. When it moves so fast it only ionises occasionally, so that its fog track is fainter. On these slides, some β ray tracks are clearly shown (Figs. 5 and 6); some are quite straight and are due to rays of high velocity, others show much bending, and these are made by β particles which have lost their great speed, and are

Fig. 5.—α- and β-Rays from radium.

knocked hither and thither by collision with the atoms of the air. It is to be remembered that the β particle is many thousands of times lighter than the α particle.

Now we come to the third type of rays emitted by the radio-active substances, the γ ray, which is the same in kind as the Röntgen ray.

Fig. 6.—β-Rays produced by γ-radiation.

The fog apparatus shows no tracks which can be directly assigned to such rays. When the β and γ rays act together, only β ray tracks are found. When a stream of X-rays passes through the chamber the result is such as is shown in the figure (Fig. 7), a mass of short, tortuous tracks originating within the path of the X-rays, and ending indiscriminately inside or outside. Photographs made by weaker beams show the individual rays more clearly. The tracks are of the same character in the two cases, and the intensity only affects the number. These are tracks such as we should expect to be made by slow β rays—slow because they are very tortuous and do not go very far. Here is one greatly magnified, showing the individual water drops deposited along the track (Fig. 8). They are actually a few millimetres long. But the X-rays are passing in straight lines across the chamber, and you see that they leave no trace behind.

FIG. 7.—Ionisation by X-ray beam about 5 mm. in diameter.

These strange results were all expected from previous investigation. It has been known for some time that X or γ rays can excite β rays in matter on which they fall; I have in recent years tried to show that the X and γ rays can do nothing else. They do not themselves ionise the air or metal or other substance through which they pass; they merely bring to birth β rays which do. When X-rays fall upon a photographic plate and bring about a chemical change, or upon the animal skin and cause a "burn," as we vaguely denote the physiological effect, the X-rays have not been the direct agents, but the β rays, which spring from them. We may venture to make a guess as to how the action takes place. When an α particle passes through a molecule it may ionise more than one atom in that molecule; in the case of a very complex molecule it must often ionise several of the atoms. Such a molecule might be expected to break up or dissociate; and it is actually found that α particles do cause dissociation. Now the β particle ionises but rarely, as the pictures show; it will be a very complex molecule in which the β particle causes ionisation of two or three of the atoms of which it is constituted. Colwell and Russ have lately shown that X-rays can break down the starch molecule, a starch solution irradiated by X-rays becoming less viscous and showing the presence of dextrin. It is reasonable to expect the very large and complex starch molecule to be broken up by the β rays which the X-rays produce; and by this direct action of the β rays on large molecules we may perhaps be able to explain all the physiological actions of radium and of X-rays.

FIG. 8.—Portions of Fig. 7 enlarged, showing the individual ions produced along a portion of one of the kathode-ray tracks.

There is good evidence to show that each of the β rays the tracks of which you see upon the screen is due to one X-ray and no more, and that the X-ray in forming the β ray gives it all the energy which it possesses. Further, if we consider the production of X-rays, we find that each X-ray that comes out of the bulb carries with it the energy of one, and only one, of the β rays which are hurled against the antikathode. Thus in the picture I have drawn (Fig. 9) β rays striking the antikathode A, X-rays move off, each inheriting the energy of one of the β rays. The β rays of the X-rays tube have themselves but very little power of penetrating materials; they move at only one-third (or thereabouts) of the speed of the β rays of radium; but the X-ray carrying the same energy is hundreds of times as penetrating, and a large number of those which are produced at the antikathode in the bulb penetrate the glass walls. Each

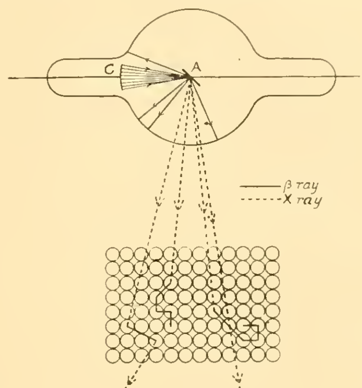

FIG. 9.

of these meets its fate sooner or later. In passing through some atom the reverse change takes place, and the X-ray disappears, handing over its energy to a β ray, which starts off with a velocity equal to that with which the original β ray finished when it disappeared in favour of the X-ray. It is as if the X-ray picked up the β ray, moved off in a straight line with it, and started it again somewhere else; or as if the β ray disappeared like a river going underground, only to reappear and continue its course. The β ray and the X-ray are interchangeable forms of energy-carrier. Further transformations may occur before the energy is spent. We may consider ourselves to be following the history of a small quantity of energy which is carried first by a β ray, then by an X-ray, then by a β ray again, and so on. The energy is kept intact in the X-ray form, but gradually frittered away in the β ray form, until finally it sinks to so low a value that it can no longer ionise or record its motion in a fog picture, and it is lost to view. Just as the α particle settles down to ordinary life as a helium atom at the end of its royal progress, so the moving electron, the β ray, becomes at last one of a crowd of electrons which are always

... the move in matter, and are the carriers of heat ... electricity. Whether it still undergoes transformations is a question we may well ask; I will consider it very briefly in a few minutes.

Transformation in either direction can only take place during the traverse of an atom. The atom is the transforming agent, but atoms differ in their transforming power. Usually the heavier the atom the more apt it is to bring about the transformation in an X-ray which tries to cross it, but there are regular exceptions. Every atom possesses one or more critical energy quantities; if the energy of the X-ray exceeds the critical value of the atom it is much more likely to undergo transformation than if it falls short. The critical values grow with the atomic weights, and are on the whole nearly proportional to the squares of the latter. Thus the critical energy of the zinc atom is about $1{\cdot}75 \times 10^{-8}$ ergs, of the nickel atom about $1{\cdot}67 \times 10^{-8}$ ergs. An X-ray, having an energy less than both these, is absorbed or transformed rather more readily by zinc than by nickel, but an X-ray having an energy greater than the lower but not greater than the higher (*e.g.* the X-ray given off by zinc when irradiated by sufficiently penetrating primary X-rays, and now known as the Zn X-ray) is actually much more readily transformed by the nickel than by the zinc.

Moreover, I believe this to be capable of extension. It is not only the X-ray that must possess energy greater than the critical value of the atom if transformation is to take place readily, but also a β ray must possess energy above the same limit if it is to be turned readily into an X-ray. Consequently a β ray is more apt to disappear if its energy exceeds the limit than if it falls short, and a stream of β rays seems actually to have less penetration than it would have if the individual rays were moving more slowly. I think I am in a position to show this as the result of recent experiment; I have found it to be so in the few cases I have tried, but there are very few cases which it is possible to try.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MILL HILL SCHOOL has recently received a gift of 5000*l.* from Mrs. Richardson, one of the nieces of the late Lord Winterstoke, formerly chairman of the governors of the school.

MAJOR SIR RONALD ROSS, K.C.B., F.R.S., formerly professor of tropical medicine, University of Liverpool, is now professor of tropical sanitation, University of Liverpool, lecturer on malaria, Liverpool School of Tropical Medicine, and physician for tropical diseases, King's College Hospital, London.

THE REV. JOHN H. ELLIS, who died in November last, has left, subject to his widow's life interest, the residue of his property, which will amount to at least 90,000*l.*, to "the University of Cambridge to be enjoyed and applied both as to capital and income by them for the general purposes of the University in such manner as they may think fit."

THE December issue of *The Reading University College Review*, in addition to its very interesting notes summarising the work recently accomplished at the college, contains an article explaining the general idea of the scheme of new buildings which the council of the University College at Reading proposes to carry out upon the main site. Another article, by Mr. J. P. Clatworthy, lecturer in mathematics at the college, deals with mathematics and the biological sciences.

THE danger of over-specialisation in higher education forms the keynote of a paper on the functions of the American college, by Prof. A. K. Rogers, in *The Popular Science Monthly* for December. As the author points out, there is a constant tendency among college teachers to cater more and more for the specialist in their own particular study, whereas if the college is to maintain its influence, it should rather aim at broadening the minds of the large majority of students of average ability. The author remarks that "the exceptional man is pretty apt to look out for himself. He will thrive probably in spite of our attempts to educate him quite as much as because of them."

THE President of the Board of Education has decided to appoint an advisory council for the Victoria and Albert Museum. The following persons have already consented to serve:—The Right Hon. Lord Reay (chairman), Mr. R. H. Benson, Mr. R. Blomfield, Sir Edward T. Cook, Mr. J. H. Fitzhenry, Mr. R. E. Fry, Mr. Frank Green, Lady Horner, Mr. Elijah Howarth, the Earl of Lytton, the Countess of Plymouth, Sir Isidore Spielmann, C.M.G. The council will be asked to advise the Board on questions of principle and policy arising from time to time, and to make an annual report on their proceedings to the Board, together with any observations on the condition and needs of the museum which they may think fit to make. It will be open to the council to constitute subcommittees on which persons who are specially qualified to advise on particular questions referred to the council may be invited by the Board to serve in addition to the ordinary members of the council.

THE fourteenth of a series of articles which has been appearing in the Journal of the Department of Agricultural and Technical Instruction for Ireland has now been issued in pamphlet form. It is written by Mr. T. Clearkin, and is concerned with technical instruction in Larne. Larne differs from many small towns of Ireland, as it has various flourishing industries giving constant employment to a considerable number of skilled workers—men and women. Many of these industries have grown up within the last twenty years, *e.g.* the manufacture of aluminium, linen-weaving, and paper-making. The shipping industry, too, is of some importance, and the engineering and building trades give employment to a fair number of apprentices. The object of the municipal technical school which has now been established in Larne is to instruct in the scientific and artistic knowledge necessary for a thorough understanding of the several callings in which the inhabitants are already engaged.

THE scheme of the competitive examination, held under the direction of the Civil Service Commissioners, for admission to the Indian Police Force is to be modified, by requiring candidates to take up English history and geography as a compulsory subject. The change will come into operation for the examination of 1914. There will then be four obligatory subjects which must be taken by all candidates, viz. English, elementary mathematics, French or German, and English history and geography. There are six optional subjects, of which candidates may take two; but, if one of the subjects selected is a modern language, it must be different from that taken as an obligatory subject. The optional subjects are intermediate mathematics, higher mathematics, German or French, Latin, Greek, and science (physics and chemistry). In addition, candidates may take up free-hand drawing. The maximum mark obtainable is the same for all subjects, except free-hand drawing, which carries only one-fifth of the mark in other subjects.

THE address delivered by Prof. Nicholas Murray Butler, president of the Columbia University, on the occasion of the dedication of the State Education Building at Albany, N.Y., last October, has been issued as a reprint from *The Educational Review* of New York. The subject of the address is the service of the university. The prime thought which underlies and gives purpose to the whole educational policy of New York from its very beginning, says Prof. Butler, is that educational progress is a unit, and that its supervision and control should be gathered into one single department of State education. Later in his address he provided an admirable definition of a university. He referred to it as "an institution where students adequately trained by previous study of the liberal arts and sciences are led into special fields of learning and research by teachers of high excellence and originality, and where, by the agency of libraries, museums, laboratories, and publications, knowledge is conserved, advanced, and disseminated. Teaching is only one function of a university, and perhaps the smallest one. Its chief function is the conservation, the advancement, and the dissemination of knowledge, the pushing out of that border line between the known and the unknown which constitutes the human horizon."

THE following advanced lectures in scientific subjects have been arranged for the present term by the University of London. Unless otherwise stated, admission is free without ticket. Detailed information will be found in *The London University Gazette* of January 1:—"The Illustration of Botanical Papers," Mr. T. G. Hill; "The Morphology of Gnetales," Prof. Margaret Benson; "The Theory of the Solid State," Prof. W. Nernst, professor of physical chemistry and director of the Institute of Physical Chemistry in the University of Berlin; "The Growth in Length of the Vertebrate Embryo," Mr. Richard Assheton; "Recent Work on the Bionomic Value of Colour in Animals, especially Insects," Prof. E. B. Poulton, F.R.S.; "Meteorology in Relation to the Navigation of the Air," Dr. W. N. Shaw, F.R.S. (in this case application for tickets of admission should be made at the Meteorological Office); "The Relations of Electrolytes to Living Tissues," Mr. G. R. Mines. (These lectures are for advanced students of the University and others interested in physiology. Any member of a London school of medicine, whether an undergraduate of the University or not, is entitled to admission to this course.) "The Protozoa," Prof. E. A. Minchin, F.R.S. (The course is open free to all members of the University, to all medical men or registered medical students, and to other persons, on application to the academic registrar.) "Some Hitherto Neglected Sources of Error in Mine-surveying and their Elimination or Reduction by Improvements in Instruments or Methods," Mr. L. H. Cooke. Six lectures in connection with the Francis Galton Laboratory for National Eugenics will be given at University College on Tuesday evenings, at 8 p.m., beginning on February 11. Admission to this course is free, but by non-transferable ticket, applications for which should be sent to the secretary of University College.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, December 10, 1912.—Prof. F. E. Weiss, president, in the chair.—T. A. **Coward** exhibited a fossil, barrel-shaped pith of a cycadean stem with small portions of the surrounding wood, with superficial markings due to the medullary rays, from a brickfield near Timperley.—T. A. **Coward**: Coloured photograph of a specimen of the Baikal or Formosan teal, *Anas formosa*, shot at Wirral a short time ago.—A. **Holt** and J. E. **Myers**: The constitution of the phosphoric acids and some of their alkali salts. There appear to be but two varieties of metaphosphoric acid and two corresponding series of salts. These salts are derived from mono- and tri-metaphosphoric acids. The tri-acid is vitreous; the mono-acid can only be obtained in solution. The monometaphosphates of the alkalies are readily soluble in water, and are prepared either by neutralising the mono-acid or by devitrifying the glass obtained by the action of heat on microcosmic salt. This is in direct contradiction to the customary statements of text-books. The more complex metaphosphates are probably double salts.—Miss P. C. **Esdaile**: The scientific results of the salmon scale research at Manchester University. The results obtained by an examination of scales from nearly 1700 fish from the Wye indicate some relation between the length of time spent in the river and in the sea. In the majority of cases, when the young fish has stayed for a considerable time in the river it has remained for a comparatively short while in the sea, and *vice versâ*. Grilse and small spring fish with a comparatively short sea-life are longer for their weight than large summer or large spring fish, and also show much more variation. Only seventy-eight of the fish had spawning marks on their scales. It was observed that fish which one year spawned as spring fish may spawn again as summer fish, and *vice versâ*. The results indicate that the scales do not provide any evidence to support the belief that spring and summer salmon represent two distinct races.—Dr. J. R. **Ashworth**: Note on the mean magnetic moment and energy of a vibrating magnet. By a mathematical investigation the author showed that the behaviour of a magnet making oscillations of large amplitude in a uniform field resembles that of a diamagnetic substance. When, however, it oscillates under the influence of a similar neighbouring magnet its behaviour has a resemblance to that of a ferromagnetic substance under the influence of heat, and the phenomenon of recalescence could in some degree be imitated under like conditions.

BOOKS RECEIVED.

Memoirs of the Geological Survey, Scotland. The Geology of Ben Wyvis, &c. By Dr. B. N. Peach and others. With petrological contributions by Dr. J. S. Flett. Pp. x+189+xii plates. (Edinburgh: H.M.S.O.; London: E. Stanford, Ltd.) 4s.

Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India (New Series). No. 54, Studies on the Mouth Parts and Sucking Apparatus in the Blood-sucking Diptera. No. 1, *Philaematomyia insignis*, Austen. By Captain F. W. Cragg. Pp. 3+17+iv plates. (Calcutta: Superintendent Government Printing, India.) 1s. 3d.

Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India (New Series.) No. 55, The Structure of *Haematopota pluvialis*, Meigen. By Captain F. W. Cragg. Pp. 3+35+vii plates. (Calcutta: Superintendent Government Printing, India.) 1s. 9d.

Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India (New Series). No. 56, Malaria in the Andamans. By Major S. R. Christophers. Pp. 4+48. (Calcutta: Superintendent Government Printing, India.) 1s. 4d.

The Fauna of British India, including Ceylon and Burma: Diptera Nematocera (excluding Chironomidæ and Culicidæ). By E. Brunetti. Pp. xxix+581+xii plates. (London: Taylor and Francis.) 20s.

Les Progrès Récents de l'Astronomie. By Prof. P. Stroobant. Pp. 173+iv plates. (Brussels: Hayez.)

Technical Electricity. By Prof. H. T. Davidge and R. W. Hutchinson. Fourth Impression. (Third Edition.) Pp. xii+590. (London: W. B. Clive.) 5s. 6d.

Notes on Chemical Research. By W. P. Dreaper. Pp. x+68. (London: J. and A. Churchill.) 2s. 6d. net.

Who's Who in Science. International, 1913. Edited by H. H. Stephenson. Pp. xvi+572. (London: J. and A. Churchill.) 8s. net.

The Dynamic Foundations of Knowledge. By A. Philip. Pp. xii+318. (London: Kegan Paul and Co., Ltd.) 6s. net.

Industrial and Manufacturing Chemistry. Organic. By Dr. G. Martin and others. Pp. xii+726+plates. (London: Crosby Lockwood and Son.) 21s. net.

Die neue Tierpsychologie. By G. Bohn. German edition by Dr. R. Thesing. Pp. viii+183. (Leipzig: Veit and Co.) 3 marks.

Memoirs of the Geological Survey. England and Wales. Explanation of Sheet 299. The Geology of the Country around Winchester and Stockbridge. By H. J. D. White. Pp. 89. (London: H.M.S.O.; E. Stanford, Ltd.) 1s. 6d.

Das Auge von Palaemon Squilla. By Dr. E. Trojan. Pp. 54+vi plates. (Vienna: A. Hölder.)

Memoirs of the Geological Survey. Scotland. The Oil-shales of the Lothians. Parts i., ii., iii. By R. G. Carruthers and others. Pp. xii+199+2 plates+map. (Edinburgh: H.M.S.O.; London: E. Stanford, Ltd.) 2s. 6d.

Catalogue of the Photographic Collection at the Forest Research Institute, Dehra Dun, India. Pp. iii+245. (Calcutta: Superintendent Government Printing, India.)

Memoirs of the Queensland Museum. Vol. i. Edited by Dr. R. Hamlyn-Harris. Pp. 216+16 plates. (Brisbane: A. J. Cumming.)

DIARY OF SOCIETIES.

THURSDAY, JANUARY 9.

CONCRETE INSTITUTE, at 7.30.—Concrete in its Legal Aspect: W. Valentine Ball.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Design of Apparatus for Improving the Power Factor of A. C. Systems: Prof. Miles Walker.

MATHEMATICAL SOCIETY, at 5.30.—The Reduction of Ideal Numbers: W. E. H. Berwick.—Proofs of Certain General Theorems Relating to Orders of Coincidence: J. C. Fields.

FRIDAY, JANUARY 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Observations of Comet 1912*a* (Gale): J. Tebbutt.—The Periodic Errors in the Right Ascensions of the Standard Catalogues: S. S. Hough.—Sun-spots and Terrestial Magnetic Phenomena 1898-1911. The Greater Magnetic Storms. II.: Rev. A. L. Cortie.—Observations of the Satellite of Neptune from Photographs taken between 1909, November 27, and 1910, April 15: Royal Observatory, Greenwich.—*Probable Papers*: The Motions and Distances of the Bright Stars of the Types B—B5 (Stellar Motions, No. 4): H. C. Plummer.—The Short Period Variable SU Draconis: C. Martin and H. C. Plummer.

MONDAY, JANUARY 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journeys in North-east Greenland: Einar Mikkelsen.

TUESDAY, JANUARY 14.

ROYAL INSTITUTION, at 3.—The Heredity of Sex and Some Cognate Problems: Prof. W. Bateson.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Acetylene Lighting: C. Hoddle.—Petrol Air Gas Lighting: E. Scott Snell.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Bridging Operations Conducted Under Military Conditions: Capt. C. F. Pym Sankey, R.E.

WEDNESDAY, JANUARY 15.

ROYAL SOCIETY OF ARTS, at 8.—The Present Condition and Future Prospects of the British Sea Fisheries: Dr. J. Travis Jenkins.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Annual General Meeting.—The Snowfall of the United States: C. F. Brooks.

AERONAUTICAL SOCIETY, at 8.30.—Stresses and Stress Diagrams Relative to Aeroplane Structure: F. Handley Page.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Presidential Address: *Bedellus immortalis*: H. G. Plimmer.

THURSDAY, JANUARY 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Effect of Junctions on the Propagation of Electric Waves along Conductors: Lord Rayleigh.—The Influence of Chemical Constitution upon Interfacial Tension and upon the Formation of Composite Surfaces: W. B. Hardy.—Duration of Luminosity of Electric Discharge in Gases and Vapours: Hon. R. J. Strutt.—Some Electrical and Chemical Effects of the Explosion of Azoimide: Rev. P. J. Kirkby and J. E. Marsh.—Negative After-images with Pure Spectral Colours: Dr. G. J. Burch.—Factors Affecting the Measurement of Absorption Bands: H. Hartridge.—A New Method of Measuring the Torque produced by a Beam of Light in Oblique Refraction through a Glass Plate: Dr. G. Barlow.—The Positive Ionisation produced by Platinum and by certain Salts when Heated: Dr. F. Horton.—The Refraction and Dispersion of the Halogens, Halogen Acids, Ozone, Steam Oxides of Nitrogen and Ammonia; and the Causes of the Failure of the Additive Law: Clive Cuthbertson and Maude Cuthbertson.—Liquid Measurement by Drops: R. Donald.—The New Theory of Integration: Prof. W. H. Young.

ROYAL INSTITUTION, at 3.—Birds of the Hill Country: Seton Gordon.

LINNEAN SOCIETY, at 8.—A Visit to Madagascar in Search of Subfossil Lemuroids: The Hon. P. Methuen.—Les Caridines des Seychelles, avec des Observations sur leurs Variations: Prof. E. L. Bouvier.—Psychodidæ of the Seychelles; Ephemeridæ of the Seychelles: The Rev. A. E. Eaton.—Odonata of the Seychelles: H. Campion.—A New Land Leech from the Seychelles: W. A. Harding.—Some New British Plants: G. C. Druce.

ROYAL SOCIETY OF ARTS, at 4.30.—Agricultural Progress in Western India: G. F. Keatinge.

INSTITUTION OF MINING AND METALLURGY, at 8.—Specification of a Precision-Theodolite (for Workings on Lodes of Medium Inclination and Narrow or Medium Thickness): L. H. Cooke.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—Further Applications of the Method of Positive Rays: Sir J. J. Thomson.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Indicators: J. G. Stewart.

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

No. 2255, Vol. 90] THURSDAY, JANUARY 16, 1913 [Price Sixpence

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THURSDAY, JANUARY 16, 1913.

A MATHEMATICIAN'S LECTURES ON AERONAUTICS.

The Dynamics of Mechanical Flight. Lectures delivered at the Imperial College of Science and Technology, March, 1910 and 1911. By Sir G. Greenhill. Pp. iii+121. (London: Constable and Co., Ltd., 1912.) Price 8*s.* 6*d.* net.

UP to the present time the study of problems relating to aeroplanes and airships has conspicuously failed to attract the attention of our leading mathematicians and mathematical physicists. This is the more surprising in view of the important part that has been played in the past, and is still being played, by methods of mathematical analysis in systematising and elucidating our knowledge of electric phenomena. A book by so trustworthy a mathematician as Sir G. Greenhill should prove of great value in clearing up the misunderstandings which have so frequently arisen as to the meaning and use (or misuse) of formulæ in connection with aeronautics.

This book claims to be the substance of the lectures given by Sir G. Greenhill at the Imperial College, and in view of the difficulties of writing a book of this character, the author has probably valid reasons for not wishing to extend its scope beyond the limits of these lectures. What he has done is to present in the first place a simple account of some of the more elementary problems which are discussed in detail in his report on the stream lines past a plane barrier, and in the second place a general summary of the formulæ that are involved in relations between lift, drift and horsepower, gyrostatic action, the screw propeller, and the pneumatical principles of the airship. As might naturally be expected by those who know Greenhill's writings, the introduction is mainly taken up with quotations from Greek, English, and other classics.

There are two methods of investigating the pressure on a plane moving through a fluid medium. One is the Newtonian method, which expresses the pressure in terms of the momentum communicated to the column of air on which the plane impinges. The other is based essentially on Bernouilli's pressure-equation, which determines the pressure from the stream line motion past the plane.

The Newtonian method still finds great favour with a large class of practical men, and many attempts have been made to apply it to aeroplanes. But beyond Newton's deduction of the so-called "sine-squared" law for a medium which, as Greenhill remarks on p. 14, is taken "to behave like a cloud of particle dust," little or no progress has been made in obtaining results that can be regarded as established on a trustworthy basis. On p. 41 Greenhill gives a figure showing a popular misrepresentation of the stream lines past a cambered plane, which finds favour with some of these neo-Newtonian would-be philosophers, but in which the absence of any broadening of the stream lines is inconsistent with the existence of any thrust or lift.

The theory of discontinuous motion as originated by Kirchhoff and Helmholtz, and developed by Lord Rayleigh, Schwarz and Christoffel, Michell, Love, and finally at very great detail in Greenhill's report, comprises all the problems that are soluble by existing analytical methods regarding fluid pressures on planes, as determined from Bernouilli's equation. It is true that they involve assumptions which at best form only a first approximation to the conditions prevailing in actual aeroplanes. But a closely analogous relation exists between the application of conjugate functions to electrical problems and the calculations required in practical electric engineering. No one will question the value of analytical applications of complex variables to electricity, and similarly these hydrodynamical investigations offer the best basis for a theoretical explanation and study of aeroplane pressures.

A considerable portion of the chapters on this subject is devoted to a discussion of the integrals involved in problems where the first integration can be effected without the use of elliptic functions. The condition for this is that there must only be two edges at which discontinuities are formed, or that the number of such edges must be reducible to two from considerations of symmetry. In such cases the "Omega" diagram representing the logarithm of the reciprocal of the velocity has only two right-angles, and the first integration only involves a quadratic expression under the radical sign. A table of different forms of this integral is given in the present book. Since the book appeared, some researches have been started at Bangor on the lift and drift of bent planes, with the view of estimating the effects of camber. One such application is suggested by Greenhill on p. 40, who, however, assumes that the stream lines divide at the bend; this we find is not the general rule, but a particular case. The object of the research is to obtain numerical tables of the lift and drift in particular systems, and so to acquire some information regarding their relative efficiency. The integrals are all capable of evaluation, and this research could probably not have been started but for Greenhill's previous work on the subject.

The chapter on gyrostatic action is of an elementary character, and those who have seen Greenhill experimenting with bicycle wheels at former mathematical congresses will not be surprised to find these experiments detailed here. The chapter on the screw propeller contains a summary of the principal theories and formulæ that have been proposed, but, as the author points out, all these are based on certain assumptions. The discontinuous motion past the blades of a propeller is far too complicated to admit of analytical investigation. The reference on p. 105 to the method of fixing two screws on the same shaft so as to neutralise the rotational angular momentum of the wake seems deserving of careful attention. This system may not have been of much advantage when applied to the early screw steamers, but with the increasing size and speed of modern flying machines, an arrangement of the kind may not improbably prove indispensable, especially in a rare medium like air. Without some such plan increased speed can only be obtained by increasing the revolutions of the screw or decreasing the pitch, and in the latter case the proportion of energy wasted in the rotation of the wake increases correspondingly, as does also the couple, tending to turn the aeroplane over sideways unless it is provided with twin-screws. The last chapter deals with the pneumatical principles of an airship, that is to say, mainly elementary hydrostatics.

For the student of exact science, this book will afford a good account of the principles and formulæ which determine the forces acting on a flying machine when it moves through the air. The study of the motions which an aeroplane undergoes under the action of these forces is another matter altogether. On the other hand, those who require to apply formulæ to actual machines will have a guarantee that the formulæ in this book are at least sound deductions from the assumptions on which they are based.

G. H. Bryan.

MUNICIPAL TRADING AND CURRENCY.

(1) *Principles and Methods of Municipal Trading.* By Douglas Knoop. Pp. xvii + 409. (London: Macmillan & Co., 1912.) Price 10s. 6d. net.

(2) *The Standard of Value.* By Sir David Barbour, K.C.S.I., K.C.M.G. Pp. xvi + 242. (London: Macmillan & Co., 1912.) Price 6s. net.

(1) THE subject of municipal trading presents an initial difficulty of definition. The economic or "reproductive" undertakings of local authorities may be divided into trading enterprises carried on for profit, and those of which the charges do not fully cover the cost and which are therefore subsidised. Mr. Knoop confines himself to the former, but includes those businesses which are sometimes carried on for profit and sometimes are not. As a result, his work has gained in completeness and thoroughness.

The arrangement of the book is admirable, and each chief division of the subject, such as Extent, Management, and Selling or Labour Policies, is separately dealt with. Moreover, both the general treatment and the criticism are, with a few exceptions, ample and well-informed. One may mention especially the case of reserve funds and renewals, in which the author's strictures appear most just, and the judicious summing-up regarding the "writing-down" of the commercial to the housing value of cleared sites. The author's conclusions limit the municipal management of competitive enterprises to those which tend to become monopolies; otherwise, "with one or two small exceptions, it is strongly to be deprecated." This appears unduly pessimistic, but few will deny the very great value of the book as a history, description and criticism.

(2) Sir David Barbour, a former Financial Member of the Council of the Governor-General of India and one of the Royal Commission on Gold and Silver, aims at placing on record the results of his wide administrative and financial experience. His book deals primarily with the causes of appreciation or depreciation, whether in a gold standard or under a system of bimetallism. Regarding the latter, he holds that a definite verdict either way is not possible, but is doubtful whether the adoption of a gold standard would have taken place if all its consequences could have been foreseen.

There is a slight preliminary treatment of some general questions of economic theory which bear upon the subject, and a fuller one of the Quantity Theory and of the relations of money, credit and prices. Here the author is inclined to underestimate the modifications of the theory that are brought about by the influence of credit, at any rate in the case of wholesale transactions. Again, it is not the total output of fresh gold, but the part of it that is used for coinage, including reserves of bullion, that influences the level of prices. The second half of the book is both the more valuable and the more interesting part of it. The points are well made that to lower general prices, decreased cost of production must be accompanied by increased output; and that "the fall in the gold price of silver was due to the fall in the gold price of commodities produced in the gold standard countries and exported to the silver standard countries." The whole book is clear and readable, and, embodying as it does the theoretical conclusions of a man of wide practical experience, contains much that is of interest and value.

N. B. Dearle.

BUILDING STONES.

(1) *Handbuch der bautechnischen Gesteinsprüfung.* Für Beamte der Materialprüfungsanstalten und Baubehörden, Steinbruchingenieure, Architekten und Bauingenieure, sowie für Studierende der technischen Hochschulen. By Prof. J. Hirschwald. Zweiter Band. Pp. xvi+388–923. (Berlin: Gebrüder Borntraeger, 1912.) Price 32 marks.

(2) *Building Stones and Clays: Their Origin, Characters and Examination.* By Edwin C. Eckel. Pp. xv+264. (New York: J. Wiley and Sons; London: Chapman & Hall, Ltd., 1912.) Price 12*s.* 6*d.* net.

(1) THE first volume of Hirschwald's comprehensive work was noticed in NATURE of June 6, 1912 (vol. 89, p. 344). This, the second and final volume, deals with the application of the methods previously described.

One of the outstanding features of Hirschwald's method is the frank acknowledgment that different types of stone demand that attention should be paid to their peculiarities of structure and mineral composition. Thus, he treats separately each of the following types:—Sandstones, grauwackes, limestones — dolomites — marbles, roofingslates, granites, gneiss with mica schists, syenites—diorites—diabases, porphyries, trachytes—rhyolites—andesites, basalts, schalsteins and tuffs. Under each of these heads he gives an account of the general petrographic characters, microstructure, chemical composition, peculiarities of weathering, special methods of testing applicable to the stone, the mode of obtaining a valuation of the stone's weather-resisting qualities from the results of testing, and remarks upon the points to be observed in the quarries.

Microscopic examination he rightly regards as of the first importance, and by its means the structure and mineral composition of the stone are analysed with great minuteness, and the results of the examination are expressed in terms of weather-resisting quality. This is done by assigning a symbol to each recognisable degree of each of the characteristics of stone structure, *e.g.*, in sandstones made of quartz grains bound by siliceous "cement" there are four grades: $K\alpha$, grains in optical orientation with their neighbours; $K\beta$, grains joined by outgrowths not so related; $K\gamma$, microgranular quartz; $K\delta$, amorphous silica. Then come thirteen grades of "contact cement" other than simple silica. The pores in the stone are treated separately; there are twenty-two grades of "texture pores," empty or variously filled, and as many grades of "structure pore" types, and so on. Tables are given in which these symbols and the numerical results of physical tests are assigned values according to a scale of weather resistance which is itself the result of observations and tests made on tried stones actually employed in buildings of considerable age. The results of observation and test are added together to obtain the desired figure representing the quality (Q). This, for example, is the formula worked out for a certain sandstone—

$$\underset{\text{Kd pgk : ce}}{0{\cdot}52(2-0{\cdot}5)}+\underset{\text{Kb}}{0{\cdot}5\times1{\cdot}5}-\underset{\zeta_r\omega_1}{0{\cdot}5}+\underset{S\eta V}{0{\cdot}45}=\underset{Q}{1{\cdot}45}=\text{I to II}$$

indicating that the quality-class of the stone is between first and second grade.

The book provides fully worked-out tables and schemes for the valuation of microscopic observations and experimental results, so that by employing them it would be a comparatively easy matter to obtain the formula for any new stone.

At the recent congress of the International Association for Testing Materials it was decided to recommend that Hirschwald's method should be tried and reported upon by testing institutions, and to assist in this process a set of type microslides and small samples of building stone with annotations by Prof. Hirschwald will be procurable from Krantz, of Bonn.

(2) It is interesting to examine Mr. Eckel's new work on building stones and clays side by side with Hirschwald's book. The former is a well-produced volume treating the subject on broad lines and mainly from an American point of view. The first two chapters are upon elementary geology; then follow eight chapters describing the geological, chemical and physical properties of the principal stone groups; one on the field examination and valuation of stone properties, and one on the laboratory testing of stone. Part ii., the short section on clays, is inadequate and rather out of place nowadays in a book on building stones.

The book contains much plain common sense, together with what can be regarded only as padding; thus, on p. 42 the author makes it clear that commercial analyses of granite are of little or no use, yet he immediately introduces twelve pages of analyses. There are more than thirty-eight pages of compiled analyses in the book and a number of tables of physical test results quoted from various sources. The latter are of small value because, as the author himself well knows, the tests are not made under comparable conditions. Though much of the tabulated matter might have been omitted without loss, the writer's outlook, as a practical engineer, on the testing problem is well worth consideration.

The restricted American scope of the work is illustrated by the scant notice taken of the trachytes, tuffs and other volcanic rocks which play an important part in Europe. Copious lists of American references are given, as well as statistics of production quoted from official publications.

In another edition, "White Man's Field, Red Man's Field and Yellow Man's Field," misquoted on p. 159 from Beare's table, should be transformed from their present "Wild West" state into the more readily recognisable "White Mansfield Stone," etc.

PHYSICS FOR CHILDREN AND STUDENTS.

(1) *The Boy's Playbook of Science.* By John Henry Pepper. Revised, rewritten, re-illustrated with many additions by Dr. John Mastin. Pp. x + 680. (London: George Routledge & Sons, Ltd.; New York: E. P. Dutton & Co.) Price 5*s*.

(2) *Examples in Applied Electricity.* By C. G. Lamb. Pp. iv + 61. (Cambridge: The University Press, 1912.) Price 2*s*. 6*d*. net.

(3) *Manuale di Fisica ad Uso delle Scuole Secondarie e Superiori.* Volume Primo. Meccanica. By Prof. Bernardo Dessau. Pp. xii + 500. (Milano: Societa Editrice Libraria, 1912.) Price 12 lire.

(1) TO say that this book is a remarkable one would in a sense be true, but might at the same time be misleading. If the term be used it must be qualified by saying that the remarkable features are mainly undesirable. No doubt the object of the book is commendable, for no one denies that it is an excellent thing to interest youth in the wonders of natural phenomena, and, further, that the treatment should be as comprehensive as possible. At the same time, it is surely better to explain a few things well than to give loose and inadequate explanations of many.

In this respect the book in question is not at all successful. A very large number of phenomena are dealt with in a manner which is often too cursory to be clear, and is sometimes, indeed, actually erroneous. Thus in treating the subject of gravitation the author, after regretting the fact that there are not many good lecture-table experiments illustrating this effect, goes on to say that "attention may be directed to the fact of a piece of potassium thrown on the surface of water in a plate generally rushing to the sides, and, as if attracted, attaching itself with great force to the substance of the pottery or porcelain." Although not an absolute statement of fact, this is at least a suggestion that the movement is the result of gravitational attraction between the potassium and the sides of the vessel. The N rays of Prof. Blondlot are spoken of as though their existence had never been disputed, and heat is spoken of as a force.

Another curious feature is the order in which the various subjects are taken. For some unaccountable reason a chapter an aerial flight—in which several pages are wasted upon an absurd and unnecessarily long list of persons who have at various dates been killed in attempting to fly—is sandwiched in the section on chemistry between the liquefaction of gases and the halogens.

It should be said that the contents of the book are limited to the consideration of the science of inanimate objects, and undoubtedly convey much useful information. Nevertheless, the weaknesses which have been referred to above render it impossible to bestow upon the book any hearty recommendation.

(2) The author of this little volume has compiled, mainly from test papers set to the students in the Cambridge Engineering Laboratory and from the papers in the Mechanical Science Tripos, a considerable number of numerical questions in electrical engineering. They are arranged in the form of papers of some eight questions each, and the answers are given at the end of the book. The questions are varied in character and, although they do not include the subjects of polyphase currents and wireless telegraphy, should prove very useful in engineering schools.

(3) This first volume of Prof. Dessau's Manual of Physics includes rather more than what is usually denoted by the title of "Mechanics" in England. Besides the ordinary mechanics of solids and fluids we find treated in an elementary manner—as, indeed, is the whole book—such phenomena as gravitation, elasticity, diffusion of gases, and the interference of waves. The book is exceedingly well printed and the diagrams are uniformly good.

OUR BOOKSHELF.

Science from an Easy Chair. Second Series. By Sir Ray Lankester, K.C.B., F.R.S. Pp. xiii + 412. (London: Adlard and Son, 1912.) Price 6*s*. 6*d*. net.

SIR RAY LANKESTER'S weekly contributions to *The Daily Telegraph* represent the high-water mark of popular papers on scientific subjects. The general public has in recent years been infected with a feverish desire for sensation; and as science can offer little to gratify that appetite, thoughtful articles upon its achievements are now relatively much fewer in the periodical Press than they were a generation or two ago. Possibly men of science are partly to blame for this state of affairs. They must be specialists in order to make progress in their own particular fields of inquiry; and they are often not only themselves unfamiliar with the commonest vocabularies of other departments of natural knowledge, but also regard the endeavour to create a comprehensive interest in nature as a thing of little importance.

There are, unfortunately, very few, if any, men of science in these days of minute specialisation who are capable of writing such illuminating papers on scientific methods and results as those in this volume and the collection which preceded it. The papers are perfect models of scientific exposition: simple, yet not childish; informative, but not tedious; bright without being flippant; sparkling with human interest and original always. Thirty-one main topics form the subjects of the chapters of the present volume, and upon all of them the author writes with freshness and breadth of knowledge that command admiration. For the student of science whose work is running in a narrow groove the papers provide a pleasant antidote; and to readers engaged in other activities they will be a revelation.

One minor point is worth mention. Sir Ray Lankester, writing on the work of glaciers, refers to glaciated rocks that have "the form of rounded humps, compared to a sheep's back, and hence called '*roches moutonnées.*'" We thought that several years ago Prof. Grenville Cole had shown this interpretation to be incorrect, for the reason that de Saussure, who first used the term, meant to suggest a resemblance of the rocks, not to a flock of sheep, but to the wigs styled in his day *moutonnées*.

An Analysis of the Church of St. Mary, Cholsey, in the County of Berkshire. By Prof. F. J. Cole. Pp. viii + 62 + 23 plates. (Oxford: B. H. Blackwell; London: Henry Frowde, 1911.) Price 5*s.* net.

THE professor of zoology in the University College of Reading teaches, in this book, a valuable lesson to church architects and archæologists, "that only an investigation by methods of precision can bring the study of the parish churches within the cognisance of serious research." Ecclesiastical architecture is now quite a dead art. It has lost the living touch with nature. Of its true natural basis even Dr. Cole has nothing definite to say. Still, he has discovered the nearest thing to it, and is well qualified to teach his lesson. The case may be put in stronger terms, but let Dr. Cole speak:

"But, unfortunately, the morphological method is hardly, if ever, carried to its legitimate extreme. The amateur, finding it easy to classify his detail according to the Norman, Early English, Decorated, and Perpendicular convention, cultivates the deadly shade of that architectural Upas. 'Yet that way perdition lies.' On the other hand, the professional architect gives us a set of drawings, of the greatest value let it at once be said, but unaccompanied by any attempt to wrest the secrets from the building he has been measuring." (Pref. iv.)

It is the author's insistence on exact measurement that will lead the student "to the bed-rock of ascertained fact." It is measurement, more than fashions or "styles," that differentiates periods in architecture. But while the author has succeeded in making out successive periods by measure, it seems not to have occurred to him to consider why certain measures were adopted, and why they should differ with the lapse of time. To some extent, the value of orientation is recognised, but it is to be hoped that the author's next "attempt to wrest the secrets" from St. Mary's, Cholsey, or any old church, will be to show that the individual measures represent celestial spaces or distances, and that the orientation is the key to the structural symmetry. JOHN GRIFFITH.

Experimental Physiology. By Prof. E. A. Schäfer, F.R.S. Pp. viii + 111. (London: Longmans, Green and Co., 1912.) Price 4*s.* 6*d.* net.

EXPERIMENTAL physiology is a convenient, but not very logical, name for that part of physiology which is not chemical. The present little book is a handy guide to the student in the practical class. It is the outcome of many years' experience in the teaching of such classes, and will form a trustworthy laboratory companion. The descriptions of the experiments are clear and concise, and a special word of praise is to be accorded to the excellent diagrams which accompany the text. The great bulk of the work which the student can himself perform is necessarily limited to the pithed frog. Experiments on living animals under anæsthesia can only take the form of demonstrations. Experiments on man himself are not restricted by law, and the present-day tendency of the physiological teacher is to increase the number of exercises which the students can perform upon themselves or upon each other, and to diminish the importance of the humble but still necessary frog. W. D. H.

The Centenary of a Nineteenth-Century Geologist—Edward William Binney, F.R.S. By James Binney. Pp. 58. (Taunton: Barnicott and Pearce, 1912.) Price 2*s.* 6*d.* net.

EDWARD BINNEY was born on December 7, 1819, and died in December, 1881. He was three times president of the Literary and Philosophical Society of Manchester, was president of the Manchester Geological Society, and in 1856 was elected a fellow of the Royal Society. With Young and Meldrum he commenced the manufacture of mineral oils from Boghead coal obtained from Bathgate, near Linlithgow, in 1850; and in fourteen years—when the patent had run out—a net profit of 60,000*l.* was made.

Mr. J. Binney's little book is a tribute to a successful man of business and a keen student of nature. Prominence is given to details of litigation of little interest to scientific readers; and filial regard will perhaps account for the remarks as to the want of acknowledgment by Williamson of what he owed to Binney in the study of fossil plants. Whether local printers or the author are responsible for the neglect of elementary rules of punctuation throughout the book is not for us to decide.

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.*]

The Double Refraction produced by the Distortions of Elastic Bodies according to Volterra's Theory.

THE interesting experiments of Prof. E. G. Coker on the application of optical methods to technical problems of stress distribution have been described in an article in NATURE of December 5, 1912. This article suggests that this would be an opportune moment to publish, outside of Italy, the results of researches which Sig. Trabacchi and I undertook some years ago for a similar purpose (*Rend. Lincei*, vol. xviii., 1909). There is this essential difference from Prof. Coker's experiments, that our object at that time was the experimental verification of precise calculations deduced from Volterra's theory of elastic "distortions" (*Ann. de l'École Normale de Pari*, 1907).

The peculiarity of these distortions consists in the entire freedom of the distorted bodies from the influence of external forces. Let it suffice to recall the two simplest cases, namely those in which a small slice, with faces either radial or parallel, is removed from a cylindrical ring of elastic matter, and the cut surfaces then glued together. There exist accordingly internal tensions, but no external forces; this makes the theoretical calculation quite rigorous, and the experimental conditions very similar to the hypotheses in the theory. I found it easy, starting from Volterra's general formulæ, which permit the calculation, point by point, of the tensions in the interior of the cylinder, to prophesy the figures of double refraction which should be observed in polarised light traversing the ring in the direction of its axis, and—more precisely—the equations of the absolutely black lines, corresponding to various orientations of the ring with respect to the principal sections of the polariser-analyser.

In the case of a radial cut I was able to predict the formation of a circle and a cross, the arms of the cross being parallel to the sections of the polarisers, irrespective of the orientation of the ring in its plane. So far as can be calculated, the radius of the circle depends only on the exterior and interior radii of the ring, and not on the angular amplitude of the cut. The circle is the locus of points where the distortion is reduced to a uniform dilatation or compression, that is, where the isotropy of the body is unaltered.

It was a less simple matter to foresee the aspect of the phenomenon in the case of a cut with parallel faces equidistant from the axis. In Fig. 1 the x axis coincides with the faces glued together after the removal of the slice. With the nicols parallel and perpendicular to this axis, the theory demands the formation of a black straight line in the direction of the x axis, and of a curve of the fourth order, tangent to the exterior circle at the extremities of the diameter perpendicular to the x axis. In Fig. 2 are reproduced the lines theoretically calculated when the nicols are inclined 45° to the direction of the cut; in this case one should observe a black line perpendicular to the x axis, and two curves similar to the two branches of a hyperbola; there should be, furthermore, four isolated black points at P, Q, R, S. The curves predicted are not neutral curves, that is to say, curves without double refraction, but isogonal curves, *i.e.* curves wherein the double refraction has a constant direction, that of the nicols. As a matter of fact, there exists in this case no neutral line, but merely six neutral points.

These calculations were, at my suggestion, verified in this institute by Sig. Trabacchi. He made use of rings of freshly prepared gelatine, and by their immersion in water avoided all possibility of accidental double refraction which might result from adhesion to the supporting glass plate. The ring, in a horizontal plane, was lowered carefully in a glass dish of water. The dish was illuminated from below by polarised light coming from a black mirror; a simple optical device was used, which allowed the entire image of the ring to be projected through a nicol of dimensions much smaller than those of the ring.

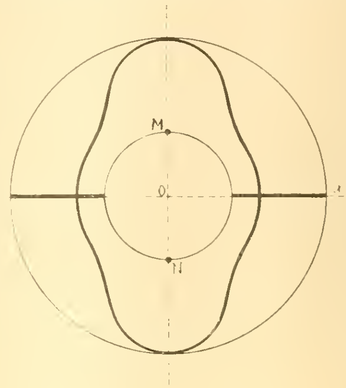

FIG. 1.

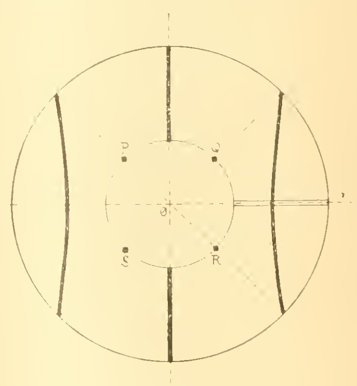

FIG. 2.

Figs. 3, 4, and 5 reproduce the photographs obtained. The first corresponds to the radial cut, the others to the cut with parallel faces, with the light polarised respectively parallel to, and at 45° from, the direction of the cut. The correspondence with the theoretical calculations is more than satisfactory; especially in view of the difficulty of making, in a material soft and easily distorted, the cuts called for by the theory.

It would certainly be preferable to make use of celluloid, as Prof. Coker now does. I did indeed attempt it at the time of these experiments, but experienced some little difficulty in glueing the celluloid after cutting it, inasmuch as, in accordance with Volterra's theory, pressure is exerted on some regions of the faces in contact, tension on others.

The optical method, which permits the investigation of the internal distribution of tensions, has thus given us the means of verifying the theory of elasticity in a salient point, namely Volterra's theory of distortions, just as it has given Prof. Coker the means of supplying, by the use of experimental models, certain deficiencies of the theory—a theory which cannot always submit to rigorous calculation the complex conditions of internal strains to which the materials of practical construction are subject.

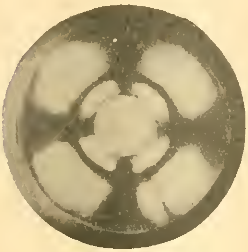

FIG. 3.

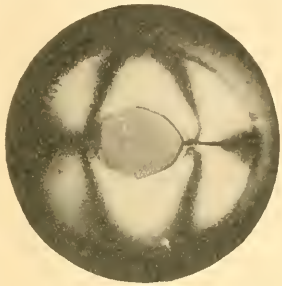

FIG. 4.

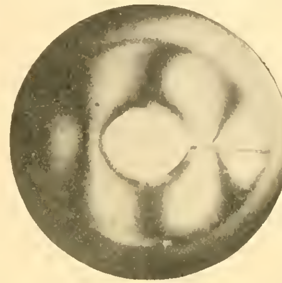

FIG.

O. M. CORBINO.

Rome, Physical Institute of the Royal University.

The Bacterial Theory of Soil Fertility.

IN vol. v., part i. (October, 1912) of *The Journal of Agricultural Science*, Messrs. Russell and Petherbridge state that "partial sterilisation appears to be the proper method of dealing with 'sick soils'" (p. 91). I venture to think that the theory of *partial sterilisation*—which is indeed very attractive—will not stand examination. According to this theory the fertility of a soil depends largely on its bacterial population, the enemies of which are destroyed by partial sterilisation, which the bacterial spores survive.

Now if this theory is correct, it should follow that complete sterilisation must diminish the fertility of a soil, since all bacterial spores will have been destroyed. This, however, is not the case, as Dr. Russell is apparently aware, for Drs. Darbishire and Russell in the same journal (vol. ii., part iii., December, 1907, p 319) state: "a few experiments have been made with soils heated to 120° C. The same kind of results are obtained as at the lower temperatures, but they are somewhat intensified."

In other words, complete sterilisation gave an increased crop over partial sterilisation. The comparative effects of complete and partial sterilisation on a soil were shown by the present writer (*Cairo Sci. Jour.*, vol. iv., No. 43, April, 1910), maize in soil untreated, soil heated to 95° C., and soil heated to 170° C. yielding green weights in the proportion of 145·5, 151·7, 1055·6 (see Fig. 1).

Without having experimented on the effects of complete sterilisation of a sick soil, Messrs. Russell and Petherbridge state (*loc. cit.*, p. 90), "our experiments thus lead to the conclusion that at least two factors are concerned in soil sickness: a falling off in bacterial activity and an accumulation of plant parasites and disease organisms."

As a matter of fact, all that is proved is, as in Drs. Russell and Darbishire's paper quoted, that partial sterilisation produces both increased crop and increased bacterial activity. The illogical conclusion is then drawn from this that increased crop is due to increased bacterial activity. This erroneous deduction would not have been arrived at had a few parallel experiments been conducted with completely sterilised soils.

Again, the authors find that plants grow as well in extracts from the "sick" soil as in extracts from partially sterilised soil. They conclude that the "sickness" is therefore not due to a soluble toxic substance. But does this prove it? The phenomenon of absorption (or adsorption) of soluble salts by soils appears to have been overlooked. Further, these results are in direct contradiction to the very elaborate experiments carried out by the U.S.A. Department of Agriculture.

With regard to the growth of seedlings in water extracts of soils, very little detail of the method of the experiments is given. For instance, it is not stated at what stage the seedling was planted in the water extract. That certain precautions may have been overlooked would appear possible from the statement (used as an argument against the toxic theory) that "cucumber seeds are very sensitive to unfavourable conditions, but they germinate fully as well in 'sick' soil as in partially sterilised soil."

Now Pickering (*Journ. Agric. Sci.*, vol. ii., part iv., and vol. iii., parts i. and iii.) pointed out that germination is delayed in heated soils—a fact long known to farmers—and supposed that this was due to the production by heat of a toxic substance. The present writer (*loc. cit.*) proved that this delay is due entirely to a physical cause, viz. the increased osmotic pressure in the water contents (and water extract) of a heated soil; this causes imbibition by the seeds to be checked, in some cases to such an extent that they rot before they have absorbed sufficient water to cause germination.

Now if the seeds in Russell and Petherbridge's experiments were germinated in the soil extracts, after five days' growth (plate iii., Fig. 3*a*), we should scarcely expect the seedling in the extract from the heated soil to have made up for time lost in germination. Even if the seeds were all germinated under the same conditions, *e.g.* in water, and seedlings in similar stages of growth were then transferred to the soil extracts—as was the case in the writer's experiment above quoted—we still have in the case of some varieties of plants this delayed germination period extended to a considerable length in water cultures; in other words, the extract from a heated soil retards growth during a period of several days after the germination has actually taken place. This appears to be connected in some way with the formation of root hairs, the growth of which is often entirely inhibited in water cultures.

The safest way of testing the effect of various soil extracts on plant growth is to sow seeds in different portions of one and the same soil (which should not be too rich), and then, after germination, water with the various soil extracts.

Until some assurance is forthcoming that the necessary precautions have been taken, the results of the water cultures mentioned cannot be accepted.

Finally, it will be difficult for any theory of soil fertility that, like Dr. Russell's, claims that all, or almost all, depends on bacterial activity to explain away the injurious effect of any one plant on all its neighbours (see present writer in *Journ. Agric. Sci.*, vol iv., part iii.).

F. FLETCHER.

Kyambu, British East Africa, November 27, 1912.

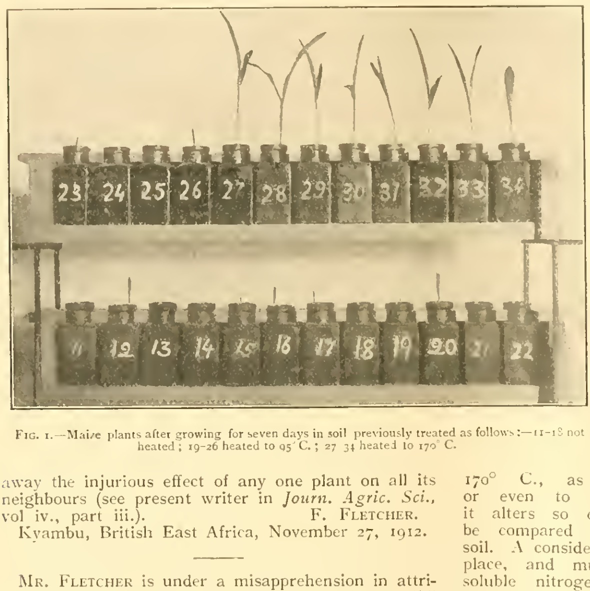

FIG. 1.—Maize plants after growing for seven days in soil previously treated as follows:—11–18 not heated; 19–26 heated to 95° C.; 27–34 heated to 170° C.

MR. FLETCHER is under a misapprehension in attributing to me a "theory" that "all, or almost all," of soil fertility depends on bacterial activity. I should certainly agree with Mr. Fletcher that any such hypothesis, if it were advanced, would be much too narrow to account for the facts.

Soil fertility is not due to the operation of any one factor, but of several. At least five conditions have to be fulfilled by the soil if the plant is to make satisfactory growth. There must be (1) adequate food supply; (2) proper water supply; (3) suitable temperature; (4) enough air for the roots; (5) absence of injurious substances or factors. Every one of these conditions is essential; any one that is unfulfilled sets a limit to the growth of the plant, and therefore to the fertility of the soil.

I have discussed the interaction of these various factors at some length in my book on "Soil Conditions and Plant Growth," and need now only refer to the place of bacterial action in the scheme.

Among the various nutrients required by the plant are the nitrogen compounds. Nitrates are the compounds usually obtained from the soil, but ammonium salts also serve; there is evidence, however, that highly complex compounds like the proteins, peptones, &c., are of little value to the plant even when they are soluble. Now the nitrogen compounds of the soil are mainly complex and insoluble, but they decompose slowly to form ammonia, which then oxidises to nitrates.

It has been repeatedly demonstrated that *when all the other essential conditions are satisfied*, an increase in the supply of ammonium compounds or of nitrates increases the amount of plant growth, *i.e.* of soil fertility. An increased supply of ammonium salts and nitrates may be brought about either by direct addition of these compounds or of substances easily converted into them, or by increasing the rate at which ammonia production takes place in the soil.

The production of ammonia in the soil is largely due to bacteria. When the conditions are made more favourable to bacterial action a marked increase in activity sets in, accompanied by an increased production of ammonia and nitrate. A corresponding increase in soil fertility follows. Partial sterilisation of the soil leads to marked increases in bacterial numbers for reasons that Dr. Hutchinson and I have discussed elsewhere. The accompanying increase in the amount of ammonia produced is so closely connected with that of the bacterial numbers that no reasonable doubt can be entertained as to its bacterial origin.

So much for the general relationship of bacterial activity to soil fertility. We can now turn to some of the details raised by Mr. Fletcher. He goes on to say that if bacterial activity has anything to do with soil fertility a completely sterilised soil ought to be less fertile than a partially sterilised soil. Unfortunately no one has ever succeeded in carrying out this experiment. When a soil is heated to 170° C., as in Mr. Fletcher's experiments, or even to 120° C., as in some of ours, it alters so completely that it can no longer be compared in any sense with the unheated soil. A considerable amount of decomposition takes place, and much ammonium and other simple soluble nitrogen compounds are formed. There is no reason to suppose that it matters to the plant whether the ammonium and other compounds are formed by bacterial action or by any other process; the essential point is that they should be formed; whatever their origin, they serve as plant nutrients. The increased gain in plant growth on such highly heated soils can be largely attributed to this cause.

The water-culture experiments, like the other experiments made at Rothamsted, were carried out with all the care and precautions that we could command. The obvious pitfalls mentioned by Mr. Fletcher were avoided. The fact that our results differ from those obtained by the United States Bureau of Soils implies no contradiction at all; they worked with "sour" soils, and we worked with the entirely different "sick" soils. We could find no evidence whatsoever of the presence of any toxin in our sick soils, or in our normal soils, but we do find abundant evidence of the activity of organisms detrimental to the ammonia-producing bacteria. We are therefore justified in regarding these detrimental organisms as one of the factors limiting soil fertility. We have shown that partial sterilisation destroys these organisms, and that it causes an increase in numbers of ammonia-producing bacteria, in the amount of ammonia produced, and in the fertility of the soil; these factors are all so closely connected with one another that no reasonable doubt can be entertained of the existence of a causal relationship between them. E. J. Russell.

Rothamsted Experimental Station, Harpenden.

Precocity of Spring Flowers.

I had occasion to remark in a letter to Nature (No. 1477, vol. lvii., February 17, 1898) on the unusually early flowering of many winter and spring flowers in the December of 1897 and the January of 1898; so many of these records have been surpassed already during the recent remarkably mild period that I am venturing to put a few of them before your readers. For the last twenty years I have kept a record of the first flowers of about eighty species of wild and garden spring flowers in this county, and the season named above is the only example which at all approaches the present one in the precocity of flowering.

The winter aconite began on December 8, and has been flowering profusely since the middle of the month, when about a hundred blossoms were gathered in one day; other early dates are December 20, 1911, December 23, 1897; the first week in January is the mean, the latest January 27, 1887. Green hellebore, January 10; usually end of February; latest, March 26, 1902. Fetid hellebore, December 1; usually early February; latest, February 21, 1904. Lesser celandine, December 1; usually early February; latest, March 12, 1900; other early records, January 20, 1898 and 1901. Wild white sweet violet in the hedges, January 5, many to be seen now, whereas mid-February to early March is its usual season. *Pyrus japonica* on many walls has been as much covered with flowers throughout December as it is usually in April and May.

Strawberry-leafed cinquefoil, December 24; usually begins in February. Gooseberry, January 5; a bush in the garden with many opened flowers. Hedge parsley abundant in the hedges in January; usually begins in mid-April. *Lonicera fragrantissima*, from December 18 onwards; usually begins early in January; earliest, December 10, 1900.

Adoxa moschatellina (Moschatel), in bud January 11; usually flowers in April. *Petasites fragrans* (winter heliotrope), mid-November, occasionally as early, but more usually December and January. Yellow coltsfoot, January 7; usually early March; earliest previously, January 21, 1898, February 20, 1897; latest, March 26, 1909. Primroses abundant in December and early January. *Omphalodes verna* abundant December; usually early March; latest, April 1, 1902. Spurge laurel, December 20; usually early in February; January 12, 1912, January 29, 1898, March 18, 1897. Dog's mercury, ♂ flowers, November 28; earliest previously, December 21, 1900; latest, March 12, 1900. Hazel, both ♂ and ♀, January 5; earliest ♂, December 24, 1911, ♀, January 16, 1906.

Chimonanthus fragrans (winter sweet), very abundant from November 14; earliest before, December 9, 1907. Yellow crocus, January 5; earliest, January 22, 1901, January 24, 1898. *Galanthus Elwesii*, November 14. Common snowdrop, December 28; earliest, January 8, 1912. Foliage has been out for some time on honeysuckle and elder, and even the "brushwood sheaf round the elm-tree bole is in tiny leaf," which, according to Browning, should not occur until April! Flower-buds are swelling on English elm and grey willow.

Eleonora Armitage.

Dadnor, Herefordshire, January 13.

Many references are being made to the numbers of plants in flower now to be found in various parts of the country. May I give a list of those I gathered on January 6 in our garden in South Devon, ranging from 230 to 500 ft. above sea-level?

Gorse (double French and single), ivy, jasmine (yellow), honeysuckle, crocus (yellow), polyanthus, primrose, berberis, *Daphne mezereum*, ribes (pink and white), daisy, veronica (purple and pink), laurustinus, azalea (white), rhododendron (red), clianthus ("parrot's bill") mignonette, heath (white and Mediterranean), violet (Russian, white, and Neapolitan), rose (pink, yellow, and "Dorothy Perkins"), genista (yellow), passion-flower, forget-me-not, snowdrop, lavender, cyclamen, tobacco-plant (white), ivy geranium (pink), wallflower, borage, *Helliborus (foetidus, orientalis,* and *niger*), arabis, *Garrya elliptica*, arbutus, solanum, pansy, *Aubrietia purpurea*, and *Pieris (Andromeda) floribunda*. T. Mary Lockyer.

Salcombe Regis, Sidmouth.

The effect of the mildness of the winter is shown in the number of wild plants now in flower, some of them evidently survivors from the autumn, others early spring flowers, and yet others entirely out of season. During a walk on January 3 and 4 from Brighton through Ditchling and Haywards Heath to Balcombe, we observed no fewer than thirty wild flowers in blossom, many of them being abundant.

The list is as follows:—Daisy, gorse, dandelion, cinquefoil, primrose, feverfew, avens, red deadnettle, hawkweed, groundsel, chickweed, shepherd's purse, yarrow, lesser celandine, garlic mustard, dwarf spurge, spear thistle, barren strawberry, ivy-leafed speedwell, corn marigold, dog's mercury, dove's-foot crane's-bill, field speedwell, herb robert, white deadnettle, cress, lesser periwinkle (a garden escape), and the following, all young plants: wild-beaked parsley, buttercup, and rose campion.

Edith How Martyn.

Light Perception and Colour Perception.

The Departmental Committee on Sight Tests has recommended a method of classifying colour-blindness by measuring the luminosity of the colour sensations by means of the flicker method of photometry. The degree of abnormality is estimated by the ratio of red to green compared with the normal. This classification is absolutely erroneous. Light perception and colour perception are quite distinct—that is to say, there may be considerable defect of colour perception without defect of light perception. The first two cases of colour-blindness (dichromics who confused red and green) examined by me on the method suggested by the Committee had a ratio identical with the normal, whilst a man who had not the least defect of colour perception had an abnormal ratio. Prof. A. W. Porter and I examined one of the above-mentioned colour-blind men by another method, and we could not detect the least defect in the perception of luminosity in any part of the spectrum. We ascertained the point of extinction and the point of reappearance of light from all parts of the spectrum. F. W. EDRIDGE-GREEN.

London, December 25, 1912.

The late Mr. Leigh Smith and Novaya Zemlya.

MAY I be allowed to point out to you that there is an omission in the short notice your publication quoted from *The Times* on the death of Mr. Leigh Smith?

Your countryman was found and rescued on the west coast of Novaya Zemlya, near the mouth of Matotschkin Sharr, by Captain J. Dalen, Dutch R.N., who was in command of the Dutch exploration vessel, *Willem Barents*. Sir Allan Young, in the *Hope*, was near, but Leigh Smith and his men did not know it when they were found and directed to the English ship by the Dutchmen. This occurred on August 3, 1882.

Next year, when the *Willem Barents* again left for exploration work in northern waters, Sir Clements Markham and Mr. Leigh Smith came over to Amsterdam and presented two fine silver cups to the president of the Dutch Committee for Polar Research Work in kind remembrance of his being seen and brought to safety by Captain Dalen and his crew.

This act of courtesy by Mr. Leigh Smith was much appreciated by our countrymen.

W. H. R. v. MANEN.

Rotterdam, January 10.

COUNTRIES AND CUSTOMS.[1]

(1) THE jealousy of the State Government renders Nepal perhaps the least-known country in the Empire among those with which we maintain friendly relations. To a student of art like the writer it is peculiarly interesting, because it forms a link between India and Tibet. Mr. Brown was allowed some liberty in visiting the sacred sites in the valley; but if he secured any new information on geography or politics he has not disclosed it. On the subject of Newar art he gives us some valuable facts and impressions. The Gorkhas, now the ruling caste, have contributed little to the art treasures of the country, and the art of the Newars represents a Tibetan substratum largely influenced from India. But it is the India of the Middle Ages, not that of the present day, when the people have come under foreign control, Mohammedan or British. The book is provided with many fine photographs, and a few sketches in colour to illustrate Newar architecture and work in metal, stone and wood. The author traces with skill the varied influences which have contributed to establish the Nepalese art school, and he gives some interesting facts, partly in corroboration, partly in extension, of those admirable essays on local religion and custom for which we are indebted to the late Dr. H. A. Oldfield. The pleasant, unaffected style in which these notes are recorded makes them more valuable than those which usually accompany books the claim of which to support lies in the illustrations alone.

(2) Our knowledge of Papua is rapidly increasing. Mr. R. Williamson's book on the Mafulu Mountain People, the work of an explorer and expert in ethnology and law, has been soon followed by the present work, which is of quite a different class. Mr. Murray admits his lack of scientific knowledge in ethnology, geology, botany, and indeed in any other branch of science; but he enjoys the advantage of long experience of the country, and Sir W. MacGregor assures us that "he has had opportunities of seeing into the heart of things in New Guinea in a way that no previous writer could ever lay claim to." This opinion is justified by the study of his book. He begins with a careful geographical account of the British province, followed by a history of the island from the age of the first explorers, an exhaustive account of the native tribes, of the methods under which the Australian officers administer justice, and of the progress in developing the resources of the country. The book is provided with a fairly adequate map and a good series of photographs.

In an interesting introduction, Sir W. MacGregor describes the task which lay before the new officials, the establishment of a land system, criminal and civil legislation. He concludes that "the two finest and best institutions I left in New Guinea were the constabulary and village police, and the missions." The book is almost purely ethnographical. The Papuo-Melanesians, he thinks, were the result of more than one immigration; but he declines to dogmatise on the origin and affinities of the Papuans. Students of cannibalism will find full details of the custom in a repulsive form. Most interesting, and full of instruction to other administrators whose lot lies among savage peoples, is the account of the methods by which the natives are being gradually civilised, and how a system of law, adopting all that is useful among the indigenous institutions, has been introduced. The book may be safely recommended as an instructive account of some of the wildest races in the Empire.

(3) The fine volume which describes this attempt to explore North China is, to some extent, the record of a failure. In the expedition organised and financed by Mr. R. S. Clark, of New York, it was proposed to start from T'ai-yuan Fu, in Shansi, and after traversing Shên-Kan, *i.e.*, the provinces of Shansi and Kansu, to skirt the Tibetan border to Ching-tu Fu, in Schuch'uan; then to descend the Min River to Sui-fu or Hsu-chou Fu, and return to Shanghai *viâ* the Yang-tzu. Its primary objects were—a careful plane-table survey of the whole route followed, astronomical observations for latitude and longitude at all important towns, to observe the meteorological conditions, to collect specimens, and to use photography in various ways. The work of the survey was placed in charge of a Punjabi surveyor, Hazrat Ali; Captain Douglas, V.C., D.S.O., of the Royal Army Medical Staff, was allowed by the

[1] (1) "Picturesque Nepal." By Percy Brown. Pp. xvi+205. (London: A and C. Black, 1912.) Price 7*s*. 6*d*. net.
(2) "Papua or British New Guinea." By J. H. P. Murray. With an Introduction by Sir William MacGregor, G.C.M.G., C.B. Pp. 388+plates+map. (London: T. Fisher Unwin, 1912.) Price 15*s*. net.
(3) "Through Shên-Kan. The Account of the Clark Expedition in North China, 1908–9." By Robert Sterling Clark and Arthur de C. Sowerby. Edited by Major C. H. Chepmell. Pp. viii+247+64 plates+2 maps. (London: T. Fisher Unwin, 1912.) Price 25*s*. net.

War Office to take charge of medical affairs, and Dr. A. de C. Sowerby was zoologist, our countrymen being thus largely represented on the scientific staff. The expedition crossed the Yellow River, went into winter quarters at Yen-an Fu, and thence the route lay roughly westward. But at Lan-chou, Hazrat Ali, while engaged in surveying, was murdered in circumstances which were never fully ascertained, and the popular excitement thus aroused necessitated the return of the party. It is much to be regretted that, in spite of every kind of pressure on the Chinese Foreign Office, no reparation has been made for this atrocious murder of a British subject.

Colossal Buddha, at Ta-fu-ssŭ, Shensi. From "Through Shen-Kan."

In addition to the account of the journey which was thus tragically interrupted, a careful itinerary and a good map are provided. Mr. Clark and Dr. Sowerby contribute reports on the results. Most of the collections, except the insects which Captain Douglas has presented to the British Museum, have gone to the United States National Museum. Some interesting mammals, including a new three-toed jerboa (*Dipus sowerbyi*) and a polecat (*Vormela negans*), were found; but the record in other departments is rather disappointing. On the whole, considering the disaster which brought the expedition to a close, much useful work was done, and the splendid series of photographs makes the work of permanent value to science.

A NEW INTERNATIONAL PHYSICAL INSTITUTE.

IN the year 1911 an account was given in this journal (vol. lxxxviii, p. 82) of a conference of scientific men in Brussels to discuss the general theories of radiation. This meeting, which was of unusual interest and importance, was due to the initiative of Mr. Ernest Solvay, of Brussels. At the conclusion of the meeting, Mr. Solvay offered to donate a sum of money to assist scientific research in the domain of physics and chemistry. After consultation with Prof. Lorentz, of Leyden, the president of the meeting, Mr. Solvay agreed to found an International Physical Institute for a limited period of thirty years, to have its headquarters at Brussels. The resources of the institute were provided by the generous donation of a capital sum of one million francs. Part of the proceeds is to be devoted to the foundation of scholarships for the promotion of scientific research in Belgium, part to defray the expenses of international meetings to discuss scientific problems of interest, and the residue to be awarded in the form of grants to scientific investigators to assist them in their researches.

For the first year, which terminates on May 1, 1913, a sum of about 17,500 francs is available for the latter purpose. It is the intention of the committee each year to give grants for special lines of work. As the first international meeting was engaged in the discussion of the theories of radiation, it is proposed this year to assist preferentially researches on the general phenomena of radiation, comprising Röntgen rays and the rays from radioactive bodies, general molecular theory, and theories of units of energy. The grants will be awarded without distinction of nationality by the administrative committee of the institute on the recommendation of the international scientific committee.

The administrative committee is composed of Profs. P. Heger, E. Tassel, and J. E. Verschaffelt, of Brussels; the scientific committee is composed of H. A. Lorentz (Haarlem), Mme. Curie (Paris), M. Brillouin (Paris), R. B. Goldschmidt (Brussels), H. Kamerlingh-Onnes (Leyden), W. Nernst (Berlin), E. Rutherford (Manchester), E. Warburg (Berlin), and M. Knudsen, secretary (Copenhagen).

The requests for subsidies should be addressed before February 1, 1913, to Prof. H. A. Lorentz, Zijlweg 76, Haarlem, Holland. They should be accompanied by definite information on the problem to be attacked, the methods to be employed, and the sum required. Definite regulations have been drawn up for the administration of the institute and for the periodical change of the members of the international scientific committee, which are intended to be representative of the active scientific workers in physics and chemistry in Europe.

Mr. Ernest Solvay has in the past been a very generous supporter of science, and has been responsible for the endowment of several scientific institutes in Brussels. The new Solvay International Institute, which is due entirely to the generosity of Mr. Solvay, is unique in character, and promises to be of great value to science. It will offer an admirable opportunity for scientific men of all nations to meet together and to exchange views on questions connected with physics and chemistry, and to obtain a consensus of opinion as to the best direction in which grants should be given to extend or deepen our knowledge of special subjects. As the funds available for distribution are limited, the decision of the committee to restrict the grants for each year to investigations in a special department of science seems a wise one, and should be more fruitful in results than if the money were distributed in small sums over a wide field of scientific inquiry. The subjects for which grants are available will, no doubt, be changed from time to time in accordance with the decision of the international committee.

E. RUTHERFORD.

THE BIRMINGHAM MEETING OF THE BRITISH ASSOCIATION.

THE arrangements for the forthcoming meeting of the British Association in Birmingham are being actively proceeded with, and the following provisional statement shows how matters stand.

Among the new features of the British Association meeting at Birmingham in September next there will be a complete series of "Citizens' Lectures." These are intended to give working men and women the opportunity of taking part in the association's meeting. They will be held each evening (except the first evening and Sunday evening) and will constitute a perfectly distinct branch of work from the regular activities of the association.

In view of the central and accessible position of Birmingham, a large attendance of members is anticipated, and a local fund of 6000*l*. is being raised in order that the arrangements may be worthy of the city. A sum of 4000*l*. has already been promised as the result of a private canvass, and a public appeal for the remainder has just been issued.

The meeting will commence on Wednesday, September 10, after an interval of twenty-seven years since the last visit to Birmingham. The usual opening business meetings will then be held, and will be followed by the inaugural address of the president (Sir William White, K.C.B.) in the evening. On Thursday, September 11, the sectional meetings will commence, and the programme includes an evening reception by the Lord Mayor (Lieutenant-Colonel E. Martineau) at the Council House. On the Friday, in addition to the usual programme of sectional and committee work, there will probably be a reception at the new University Buildings, Bournbrook, and special arrangements will be made to show members over the various scientific departments. In the evening one of two discourses will be given.

The excursions on the Saturday will include Stratford, Coventry, Kenilworth, Warwick, and Shrewsbury; whilst special expeditions will be arranged for archæologists, botanists, geologists, and geographers. On the Sunday there will be special services at the Cathedral and other places of worship. The following day there will be an entertainment given by the local committee. On Tuesday, September 16, the draft programme includes a conference of delegates, a garden party in the afternoon, and the delivery of the second discourse in the evening. The usual closing business meetings will be held on Wednesday, September 17.

LORD HALDANE ON EDUCATIONAL ORGANISATION.

THE announcement made by the Lord Chancellor on Friday last, in replying to the toast of his health as the guest of the Manchester Reform Club, will be welcomed by all who have the interests of English education at heart. Speaking after consultation with the Prime Minister, the Chancellor of the Exchequer, and the President of the Board of Education, Lord Haldane said the next great social problem with which the Government intends to deal is education and its organisation. As readers of NATURE will know, the British Science Guild and other important bodies working for the provision of a properly coordinated and complete system of education have long urged the need for action on the part of the State if this nation is, in the coming keen competition for the markets of the world, not to be outclassed by nations which have organised their educational forces.

It may be hoped that this great question will be approached in the spirit of Lord Haldane's remarks, and that our legislators will unite in building up a complete national system of education suited to modern needs.

In the course of his address Lord Haldane said:—

In what I am going to say I am not speaking casually, or with any light sense of responsibility, but, after consulting with the Prime Minister and the Chancellor of the Exchequer and Mr. Pease, we have decided that this question is the next and the most urgent of the great social problems we have to take up. Of course, it is education. The state of education in this country—elementary, secondary, and higher—is chaotic, and my colleagues and I feel that the time has come when a step forward must be taken and on no small scale. As a second message, Mr. Lloyd George sends word that his heart is in this question just as it is in insurance, and that he is ready to throw himself into it with the whole-heartedness with which he threw himself into the insurance question. After consultation that is what we think. As a nation England has never been sufficiently interested in education to stir up its leaders about it. That arises partly from the fact that the leaders themselves have not thrown themselves into the education question sufficiently to stir up the nation. Now is the time for the leaders to make an effort, and that is what the Prime Minister and the Chancellor of the Exchequer think. How is it to be done? Education, if it is to be interesting, must be an appeal to the spirit. It must be an endeavour to raise the level intellectually and morally of the coming generation, upon whose superiority the country will depend in the days to come to meet growing competition. It is worth while making a sacrifice to bring about that result. I do not want you to be under any illusion. It is a tremendous question which we have before us. It is a costly question, too, but I will point out that the expenditure is productive expenditure.

In looking at the balance-sheet in the matter we must not look only at the debit items. If the nation is educated as it should be, the charge for old-age pensions will be smaller than it is now, because there will be fewer people left with less than 13*l.* a year. Income tax will yield more, because more people will be over the income tax limit. The taxes will yield more because the production of the country will be greater. Education means increased power of production. Then the bill on what I may call the negative side of the account will be smaller. Smaller payments will be necessary on account of crime and drunkenness. All social shortcomings will be less among better educated people. We must keep up the capacity of this country to lead in the production of the world. The cost of education on a great scale, even though it involves a great sacrifice, is a sacrifice well made.

We intend to try to make education an interesting subject. I wish that we had Matthew Arnold again among us, writing as he wrote thirty-five years ago. One thing is quite certain—what is about to be done for the coming generation must not be done at the expense of the ratepayer. In Scotland there is a university to one and a half millions of the population; in England a university to three and a half millions. Some remedy for that must surely be found.

A national system of education must be not merely elementary, secondary, or university, but it must be one entire whole, and it must start from this—the child must be made fit to receive the education. A great step forward in that direction has already been made. Then we must remember that though we are making provision by which children may have chances of becoming university students, the bulk of them will not get beyond the elementary school, and full provision must be made for them to do the best that they can within their limits. We must do something substantial in the way of making the teacher's profession more popular.

I am not speaking in the air on this question. We have been busy with the experts for some time, and I should not have ventured to speak as I have done if we did not see pretty clearly the path along which we are going. When we come to work out these things comprehensively it is marvellous how difficulties disappear. I see no reason to despair of our accomplishing rapidly such a reform in our educational system as should put us at least on a level with any other nation in the world.

NOTES.

The scientific world has lost one of its veterans by the death of Louis Paul Cailletet in Paris on January 5. Born in 1832, at Chatillon-sur-Seine, he studied at the School of Mines and the Faculty of Sciences at Paris. His first work was in metallurgy, and he made many scientific investigations into the principles of cementation and puddling. Later work on the theory of smelting led him to investigate the properties of gases under pressure. As a result of an admirable series of researches he was able to announce in 1877 that he had liquefied oxygen by cooling produced by sudden release from considerable pressure. The same result was obtained by Pictet at Geneva in the same year by a different method, and quite independently. Later investigations enabled all the so-called permanent gases to be liquefied with the exception of hydrogen, which was left for Wroblewsky, who had been his pupil, and much of the later work of Amagat, Dewar, Kamerlingh Onnes, Linde, and Claude was the direct result of his methods and discoveries. In conjunction with Mathias, investigations on vapour pressures and critical volumes led to the discovery of the law of the rectilinear diameter, which has had such fruitful results. Always devoted to scientific work, he became much interested in aviation, acting for many years as the president of the Aëro Club of France. The Academy of Sciences elected him a corresponding member in 1877, and gave him the Jecker prize and elected him an academician in 1884. In 1910, on the occasion of his academic jubilee, he was proclaimed the father of modern cryogenics.

Zoologists and naturalists interested in the big game of East Africa, and sportsmen wanting to know something of the country, of the methods of transport and of the paraphernalia for a hunting trip, will not regret spending a couple of hours at the Holborn Empire, where some of the results of Mr. P. J. Rainey's recent photographic studies of wild animals are being shown by the Jungle Film Company of

America. The exhibition consists of a series of moving pictures, the sequence of which, to relieve the eyes of the audience, is periodically interrupted by a show of ordinary slides, the whole depicting various incidents and adventures that happened during the trip. The best and most interesting pictures were taken behind an artificial screen at a water-hole, which was visited by elephants, giraffes, zebras, oryxes, baboons, and other species, the scene being enlivened by a fight between two rhinoceroses and by the sensational death of one of them, which charged the photographer in a disconcerting manner. The main object of the expedition was, however, to trap and photograph, not to kill. One of the scenes depicting the struggles of a trapped hyæna is perhaps needlessly prolonged, not to say painful, and the attempt of the expositor to rob the creature of the well-deserved sympathy of the audience by abusing him as a scavenger and body-snatcher will appeal only to the childish-minded, and it will, of course, be well known to English sportsmen that the idea of hunting lions with dogs, which is claimed as a novel feature of the trip, was regularly practised more than half a century ago by that intrepid sportsman Gordon Cumming.

JOHN NAPIER of Merchiston made the first public announcement of his invention of logarithms in 1614, and an English translation of his work was issued two years later, that is, one year before his death. Announcement having been made of a proposal to celebrate the tercentenary of Napier's discovery next year, it may be of interest to state the position of the matter. The Royal Society of Edinburgh has invited the cooperation of other scientific and educational bodies in arranging for this celebration, and the great majority of these institutions and corporations have nominated representatives upon the general committee, which will be convened at an early date to consider the whole question. Among the bodies which were invited by the Royal Society of Edinburgh to cooperate were the Edinburgh Town Council, the universities and technical colleges of Scotland, the Faculty of Actuaries, the Merchant Company, the Heriot Trust, the Edinburgh Committee for the Training of Teachers, the Chamber of Commerce, Merchiston Castle School, and the like. The only societies outside Scotland which were asked to send representatives to the general committee were the Royal Society of London and the Royal Astronomical Society, these being respectively included because of their national importance as the highest representatives of science in our country and of that particular science of astronomy which was the first to benefit by Napier's great invention. We understand that nothing has yet been decided as to the character of the celebration; a congress of calculators and an exhibition of all kinds of aids to calculation in the form of tables or instruments have been mentioned; but no scheme can be definitely adopted until the general committee has met.

WE are informed that Vittorio Emanuele III., King of Italy, has consented to the use of the prefix "Royal" by the Italian Geographical Society.

SIR RICKMAN GODLEE, president of the Royal College of Surgeons, will deliver the Hunterian oration in the theatre of the college on Friday, February 14, at four o'clock.

THE death is announced, at eighty years of age, of Dr. W. H. Dickinson, past-president of the Royal Medical and Chirurgical Society and of the Pathological Society, and at different times Croonian, Lumleian, and Harveian lecturer, as well as censor, of the Royal College of Physicians.

THE Geological Society of London will this year award its medals and funds as follows:—Wollaston medal, Rev. Osmond Fisher; Murchison medal, Mr. G. Barrow; Lyell fund, Mr. S. S. Buckman; Bigsby medal, Sir Thomas Henry Holland, K.C.I.E., F.R.S.; Wollaston fund, Mr. W. W. King; Murchison fund, Mr. E. E. L. Dixon; Lyell fund, Mr. Llewellyn Treacher; Barlow-Jameson fund, Mr. J. B. Scrivenor and Mr. Bernard Smith.

PROF. GUIDO CORA informs us that the fall of a house in Rome on January 8 was clearly registered at the Collegio Romano Observatory by an Agamennone seismograph at 4.26 a.m. The first earth movement came from the north-east, corresponding to the position of the Via del Tritone, where the fall occurred, by which fifteen people were killed, and afterwards the ground continued to vibrate for twenty minutes.

LIEUT. FILCHNER, the leader of the German Antarctic expedition, returned from the south to Buenos Aires on January 7. He has apparently crossed an ice-belt of great width (1200 nautical miles), and discovered, last February, a new land in 76° 35′ S., 30° W., extending to 78° or 79° S., to which the name of King Luitpold has been given. Its boundaries and extent are by no means clearly defined in reports to hand. Lieut. Filchner declares himself satisfied with the results, but the expedition has returned earlier than was expected, and he expresses the hope that work will be carried on. There is later to hand a report of dissension between the members of the nautical and scientific staffs of the expedition, which, it is to be hoped, may not have prejudiced the work.

GERMAN geographers and their colleagues elsewhere are concerned over rumours of disaster to the German expedition in Spitsbergen. The ship has been abandoned in the north at Treurenberg Bay, and though it may be salved in the summer, it is by no means certain that the crew and staff, or some of their members, are not lost or in extremity, for the leader, Lieut. Schröder-Stranz, was away on a sledging journey from which he had not returned. Captain Ritschel, with infinite difficulty and much suffering, has made his way to Advent Bay, and a relief expedition has been organised. The original party was not apparently prepared to winter in the field.

CAPTAIN EINAR MIKKELSEN's account of his expedition to north-east Greenland, presented at the meeting of the Royal Geographical Society on January 13, sounded like a chapter of accidents successfully overcome. At the very first, in the summer of 1909, he was delayed with trouble over his dogs, and those he obtained appear to have done him but poor service. Much additional labour devolved upon himself and his companion, Iversen, who made the journey to Danmarks Fjord, and they had to struggle as well against privation, and, from time to time, sickness. They were in large measure dependent on caches of provisions, the contents of which might or might not prove sufficient for their needs, and on obtaining game, the appearance of which was problematical. Captain Mikkelsen outlined his discoveries relating to the important work of the Mylius Erichsen expedition, as it was his main object to recover the records of the lost leader and his companions, Brönlund and Hoeg-Hagen. He was successful, and referred to the serious import to his own plans of the report left by Erichsen of the non-existence of the Peary channel. This channel Mikkelsen had intended to follow to the north-west coast. By his experiences of boat-work among the ice, and of journeying over the sea and inland ice, and coastwise, Mikkelsen has added comprehensively to our knowledge of the conditions of travelling in Greenland.

M. A. Prazmowski contributes a second study on the nitrifying organisms of the group Azotobacter in the *Bull. Internat. de l'Acad. des Sciences de Cracovie* (No. 7B, July, 1912). Azotobacter is a true Schizomycete, though it has affinities both with the protozoa and with the unicellular algæ. Its pre-eminent function is to fix nitrogen, and it is probable that it can obtain nitrogen either from nitrogenous compounds or from the free nitrogen of the atmosphere.

Malaria is prevalent in the Andaman Islands, Bay of Bengal, and a valuable report on the subject has been furnished by Major Christophers (Scientific Memoirs of the Government of India, No. 56, 1912). The chief carrier in the settlements is the anopheline mosquito *Nyssomyzomyia ludlowi*, a species which breeds in and about salt swamps, and was not found at a greater distance from salt or brackish water than half a mile. It was proved to carry the malignant tertian parasite, and it is quite probable that it carries all forms of the malaria parasite.

Dr. Wielowiejski has directed our attention to an article by Prof. Hofer in the *Osterreich. Fischerei Zeitung* (No. 21, 1912) on the biological purification of sewage effluents, &c., by means of fish. Tanks have to be provided, in extent at the rate of one hectare (2·5 acres nearly) per 2000–3000 persons. They work well even in winter, when covered with ice, and are quite equal in efficiency to irrigation in sewage farms, and financially the return is better than from sewage farms, as 500 kilograms of fish (carp) are reared per hectare (in what time is not stated).

In spite of the enormous and rapidly increasing output of zoological literature at the present time, it is surprising what a large number of well-known types, constantly studied by students in the laboratory, remain inadequately described. A good general account of the morphology of such forms is always valuable, even if it be restricted to some particular system of organs, and we welcome the appearance in the *Zeitschrift für wissenschaftliche Zoologie* of two monographs of this kind. The description by Rudolf Hillig of the nervous sytem of *Sepia officinalis* (*op. cit.*, vol. ci., part 4) is a detailed and admirably illustrated piece of work, which cannot fail to be widely useful, though we fear that but few students will be able to find time to follow it out in all its intricacies. The same remarks apply with equal force to the more comprehensive account by Erich Reupsch of the anatomy and histology of the common Heteropod, *Pterotrachea coronata* (*op. cit.*, vol. cii., part 2).

Two notable monographs on the invertebrate fauna of Japan have recently been published in the Journal of the College of Science, Imperial University of Tokyo. The first (vol. xxx., art. 2) is on "The Errantiate Polychæta of Japan," by A. Izuka, and contains a systematic account of the group illustrated by twenty-four plates. The term "errantiate," instead of "errant," strikes us as being somewhat peculiar, and we do not remember to have seen it before. The second (vol. xxix., art. 2) is a posthumous work on the actinopodous Holothurioidea, by the late Prof. K. Mitsukuri, whose death was such a grievous loss to zoological science. This work has been edited by Prof. I. Ijima and Mr. H. Ohshima, and is illustrated by admirable text-figures of the calcareous skeletal elements and plates of external form. The coloured illustrations, drawn from life, are very beautiful, and for quaintness of form and colour it would be difficult to find any invertebrate to surpass *Enypniastes eximia*.

Observations made on Long Island at the beginning of June, 1911, have enabled Dr. L. Hussahof, in *The American Naturalist* for December, 1912, to obtain new information with regard to the breeding habits of the sea-lamprey (*Petromyzon marinus*). It has been considered that fertilisation in these lampreys is internal—a supposition which may be explained by the fact that the eggs can develop parthenogetically, but in ordinary cases normal fertilisation takes place. Both this formation and spawning occur in a kind of nest made in the bed of a stream by carrying away stones in the circular sucking mouth until a basin-shaped depression is formed, on the bottom of which sand accumulates. Like eels, lampreys never return to the sea after spawning. Death appears to be mainly due "to the cycle of metabolic processes initiated on the maturing of the gonadial products"; but this may be aided by reduced vitality due to the labour of removing stones from the nest, and also by the development of "fungus" in the self-inflicted wounds made during the breeding season.

The determination of the magnitude of the experimental error in agricultural field trials has recently attracted considerable attention in this country, and has now been investigated in the United States by Prof. Lyttleton Lyon, of Cornell. The results are published in the Proceedings of the American Society of Agronomy, and afford interesting confirmation of those obtained at Rothamsted and at Cambridge.

MESSRS. LAUDER AND FAGAN have issued in bulletin form (Report 26, Edinburgh and East of Scotland Agricultural College) a summary of their investigations on the effect of heavy root feeding on the milk of cows. They show that the feeding of a ration containing a large quantity of water does not reduce the percentage of fat or increase the percentage of water in the milk. A more concentrated ration certainly yields a larger quantity of milk, but the turnip ration, on the other hand, gave richer milk and at a lower cost.

AN account has been published from the Entomological Laboratories of the Agricultural Research Institute, Pusa, of the Tetriginæ (Acridiinæ), by Dr. J. L. Hancock. The members of this subfamily are so variable in structure and coloration that difficulty is experienced in drawing specific distinctions between some of the closely allied forms. The author has carried out a systematic arrangement of the species, and has succeeded in dividing the members of this genus into two groups by the characters of the frontal costa and the position of the superior paired ocelli.

THE existence of circular currents in the Sea of Japan, we learn from *The Japan Chronicle*, Kobe, of December 19, 1912, has been established by Dr. Wada, the meteorologist of the Korean Government-General. Great weight is attached to the discovery by Japanese authorities, who regard it as having an important bearing on the distribution of marine life and even on human migrations in East Asia. Dr. Wada carefully studied the movements of nearly 400 mines, laid in Vladivostok Bay by the Russians and Japanese during the war, which drifted on to the coasts of Japan, and further observed the drift of 120 bottles thrown into the Sea of Japan from a steamer belonging to the Government. From the data obtained, Dr. Wada concludes that the Liman current, running down from the Siberian coast, flows southward past Kang-won and Ham-gyong Provinces, Korea; from Cape Duroch the stream sweeps round to the coast of Echizen, Japan, whence it goes northward along the coast of Japan together with the Tsushima current. One stream goes out into the Pacific through the Tsugaru Strait, and another stream continues northward to Tartar Strait, where it rejoins the Liman current, thus forming a complete circle.

SHORTLY after the great Valparaiso earthquake of August 16, 1906, attention was directed to certain luminous phenomena that were observed before, at the time of, and after the earthquake. The observations have recently been analysed by Count de Montessus de Ballore, the director of the Chilean Seismological Office (*Bollettino* of the Italian Seismological Society, vol. xvi., pp. 77–102). The total number of records collected is 136. Of these 44 are decisively, and 16 implicitly, negative; in 38 cases some lights of an indefinite character were noticed; in the remaining 38 records the observation of luminous phenomena is more or less explicit. Many of the negative records are communicated by persons accustomed to scientific investigations, and in some cases contradict alleged observations of lights at the same places. It does not follow that the lights, when observed, were connected with the earthquake, for, in the centre and south of Chile, a storm raged during the night of the earthquake, and it was from this part of the disturbed area, and not from the epicentral district, that most of the observations came. Count de Montessus therefore concludes that, for the Valparaiso earthquake at any rate, the connection of the luminous phenomena with the earthquake is not proven.

IN *Science* of December 6 Prof. J. E. Church, jun., in charge of Mount Rose Observatory, on the summit of a peak of the Sierra Nevada Mountains (altitude 3292 metres), gives an interesting account of its plans and progress. The meteorological station is at present the highest in the United States, and was established privately a few years ago for the purpose of ascertaining the minimum temperatures at that point; it was subsequently attached to the University of Nevada. Although the staff only occupies the observatory during part of the year, the station is well provided with specially constructed self-recording instruments, and bids fair to become of considerable importance in the study of mountain meteorology. Among the main problems which occupy attention may be mentioned (1) the prediction of frosts at lower levels and the relationship of the former to the passing of storms over the summit. A temperature survey has been in progress for two seasons for the purpose of delimiting areas suitable for fruit-growing, and several auxiliary stations have been established at various levels. (2) The influence of mountains and forests on the conservation of snow. A special bulletin on this subject is now being prepared. Prof. Church points out that "forests may be too dense as well as too thin for the maximum conservation of snow." The ideal forest seems to be one filled with suitable glades, which may be produced by judicious pruning or by proper planting.

UNDER the title, "A Class of Periodic Orbits of Superior Planets," Prof. F. R. Moulton, in a paper reprinted from the Transactions of the American Mathematical Society, xiii., 1, discusses the problem of three bodies of a distant particle moving subject to the attraction of two finite bodies which revolve about the common centre of gravity, with special reference to the case of nearly circular orbits.

IN a note contributed to the *Atti dei Lincei*, xxi., (2), 7, Dr. Giovanni Giorgi considers the solution of problems in elasticity where after-effect (the *Nachwirkung* of Boltzmann) is taken into account. The object is to show that when any problem in statical elasticity has been solved, the corresponding solution in the present instance can be deduced by substituting an expression involving a differential operator for the constant modulus of elasticity.

VARIOUS definitions of a curve have been given by Jordan, Schönflies, Young, Veblen, and others. In the Memoirs of the College of Science and Engineering, of Kyoto, Japan, Mr. Takeo Wada examines these and proposes a new definition of a simple curve, based, like those of Veblen and Young, on the theory of sets of points. It is shown that this definition of a curve is equivalent to that of Jordan, and it appears independent of the dimensions of the space in which the curve exists.

Part 2 of vol. viii. of the Bulletin of the Bureau of Standards contains a complete description of the work done by Messrs. E. B. Rosa, N. E. Dorsey, and J. M. Miller in determining the value of the international ampere, which deposits 1·11800 milligrams of silver in one second, in terms of the absolute ampere, which is one-tenth of a c.g.s. unit of current on the electromagnetic system. The method used is that of the Rayleigh current balance of the single moving-coil type. The balance itself was a 30-cm. beam Rueprecht, from one pan of which the moving coil was suspended between two coaxial fixed coils. The coils were water-cooled so as to minimise convection currents in the air. The ratio of the radii of fixed and moving coils, 50 and 25 cm. respectively, was found by using them as concentric galvanometer coils. The quantity directly measured by the authors was the electromotive force in international volts at the ends of a standard ohm carrying one absolute ampere, but by comparing their result with that of Messrs. Rosa, Vinal, and McDaniel, giving the international volts at the ends of the resistance when an international ampere passed through it, they find that the absolute ampere deposits 1·11804 milligrams as against the international ampere, 1·11800 milligrams, of silver in one second.

The past year has been notable as regards the smaller electrical apparatus in that great development has taken place in domestic electrical appliances. Both manufacturers and central station engineers have at last awakened to the fact that in order to compete with the gas companies in cooking and other appliances an organised campaign is necessary to bring before the public at large the advantages of the smaller electrical domestic apparatus as produced at the present time. Consequently the engineers of municipal undertakings and supply companies have been working hard to bring the hitherto comparatively unknown domestic electrical appliances before their consumers, and the manufacturers also by improved and simplified heating units have largely contributed to the success of this campaign. The present year should see a reasonably cheap and economical electric oven put on the market to compete with the everyday gas cooker, which at present, on account of its low initial cost, still holds the field against the electric oven among the general public. Several English manufacturers have also during the past year put down extensive plant for the production of small electric motors and fans, the greater part of which up to quite recently were imported from Germany and Italy.

Reproductions from photographs of H.M. submarine-boat $E4$ appear in both *Engineering* and *The Engineer* for January 10. This boat is of the latest type, constructed by Messrs. Vickers, Ltd., at Barrow-in-Furness, and is of large size and great speed. The surface speed of about sixteen knots is obtained from heavy oil-engines of more than 1500 brake-horse-power. It is understood that the vessel is nearly 180 ft. in length and 23 ft. in beam; the submerged displacement is about 800 tons. A wireless telegraphy mast is fitted, and there is a large rudder at deck level, which improves the steering of the vessel when submerged. It is also stated that the vessel accommodates disappearing guns. When travelling at the surface, $E4$ draws about 12 ft. of water. Very little authoritative information has been given regarding vessels of the E class, for obvious reasons.

The fortieth year of publication is reached by the 1913 issue of "Willing's Press Guide." The volume provides an admirable index to the Press of the United Kingdom, and useful lists of the principal Colonial and foreign periodical publications. The journals and proceedings of the various scientific and other learned societies are duly indexed.

The address on "The Place of Mathematics in Engineering Practice," delivered by Sir William White before the International Congress of Mathematicians at Cambridge last August, and referred to in our report of the proceedings of the congress (September 5, vol. xc., p. 4), has been published in full in our comprehensive contemporary *Scientia* (vol. xii., N. xxvi.-6), the London agents of which are Messrs. Williams and Norgate.

OUR ASTRONOMICAL COLUMN.

The Sun's Magnetic Field.—The question of the sun possessing a magnetic field, similar to the terrestrial magnetic field, is discussed, especially with regard to the phenomena of the sun's upper atmosphere, by M. Deslandres, in No. 27 of the *Comptes rendus* (December 30, 1912). He first discusses the matter theoretically, and, supposing the magnetic field to be produced by the rotation of the sun's electric charge, shows that a solar ion expelled vertically from the sun should be so deviated by the field as to describe a helix having its axis parallel to the field; if many luminous ions are expelled in the form of a prominence the helical motion at the base of the prominence, as seen from the earth, will depend upon the position of the prominence in the solar magnetic field. From a number of observations, M. Deslandres shows that the recorded phenomena are in accordance with the demands of the theory, and he accepts as certain the existence of a general magnetic field about the sun, similar to that of the earth, and in general much more feeble.

The Integrated Spectrum of the Milky Way.—The Harvard analysis of the spatial distribution of the spectra of more than 32,000 stars indicates that the Sirian type predominates in the Milky Way, and therefore the integrated spectrum of the galaxy should be of the A type. To test this conclusion Dr. Fath has actually secured spectra of certain large areas of the Milky Way, and finds that his results are not exactly confirmatory. With the special spectrograph he used for his work on the zodiacal light, he exposed a plate for a total of 30h. 20m. on the rich region of the Milky Way that is partially bounded by the stars γ, δ, and λ Sagittarii; a second plate was exposed for a total of 65h., and gave better results.

The general character of the spectrum so secured is solar in that it shows the F, G, H, and K lines, and three broad absorption bands more refrangible than K; a bright line is suspected at $416\mu\mu$, but may be merely a subjective phenomenon due to contrast. Plates of other regions were taken, and agree in indicating that the integrated spectrum of the Milky Way is of the solar type.

Dr. Fath suggests that his result differs from that obtained at Harvard because he dealt with altogether fainter stars, and that beyond a certain undetermined magnitude stars of the solar type predominate. A perfectly independent photographic investigation also indicates that, in the mean, the fainter stars of the Milky Way are the redder. These results, if they prove to be perfectly general, are most important from the cosmological point of view. (*Astrophysical Journal*, vol. xxxvi., No. 5, p. 362.)

COMETS DUE TO RETURN THIS YEAR.—Mr. Hollis, continuing a function performed by the late Mr. W. T. Lynn for many years, discusses briefly in *The Observatory* (No. 457) the periodic comets due to return this year. Holmes's comet, period 6·86 years, is due to pass perihelion early in the year, but the conditions are not very favourable; it was observed in 1899 and 1906. Finlay's comet, period about 6·5 years, was discovered at the Cape in 1886, and was observed in 1893 and 1906; at the latter return it passed perihelion on September 8. Both these comets are of the Jupiter family, to which also belongs the object (1906IV) discovered by Dr. Kopff in 1906, and calculated to have a period of 6·67 years. Two other comets may appear, but are not expected with any great confidence. The first, discovered by Mr. E. Swift in 1894, was considered to be possibly identical with de Vico's lost comet, but has not been seen since, although a thorough investigation gave a period of 6·4 years. Finally, Westphal's comet of 1852, calculated to have a period of about sixty years, may appear, and five search-ephemerides for it have been published by Herr Hnatek in the *Astronomische Nachrichten*, No. 4619.

PARALLAX INVESTIGATIONS.—In parts iii. and iv., vol. ii., of the Transactions of the Astronomical Observatory of Yale University, Dr. F. L. Chase and Mr. M. F. Smith publish the results of their heliometer observations of the parallaxes of forty-one southern stars, most of which have large proper motions. The methods employed and the individual results are discussed at length, and then the final results are collected into one table showing the magnitude, spectrum class, position, proper motion, and parallax of each object. Seven stars show a total proper motion exceeding 1″, and eight have parallaxes exceeding 0·1″; only two stars are common to both categories. The volume concludes with a valuable catalogue of the collected parallax results obtained at the Yale Observatory for nearly 250 stars.

EXPLOSIONS IN MINES.[1]

AT the end of the report before us the Committee gives the following short summary of its principal contents:—

"A method is described by which the relative inflammability of different dusts can be ascertained by measuring the temperature of a platinum coil which just ignites a uniform cloud of dust and air projected across the coil fixed in a glass tube. It is shown that the relative inflammability does not depend upon the 'total volatile matter,' but on the relative ease with which inflammable gases are evolved.

"The order of inflammability so obtained corresponds in a remarkable degree with the percentage of inflammable matter extracted from the same coals by pyridine.

"We are of opinion that these two methods form a valuable means of discriminating between different coals in regard to the sensitiveness of their dusts to ignition. It must, however, be borne in mind that these tests have been made with dusts artificially ground and sieved to an equal degree of fineness, and since coals differ considerably in their power of resistance to pulverisation, the friability of a coal must be taken into account."

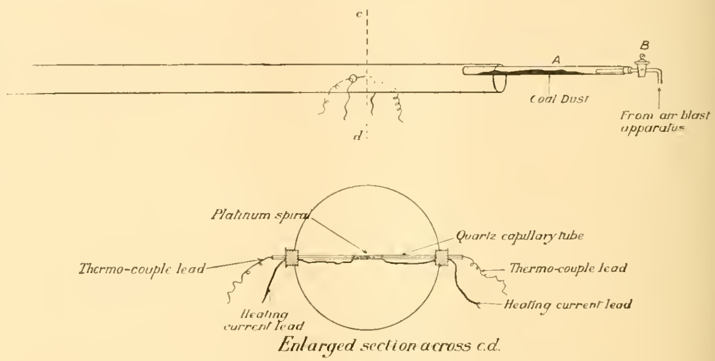

FIG. 1.—Apparatus for determining the relative ignition-temperatures of coal-dust clouds.

In the body of the report the subjects are discussed under three heads:—On the relative inflammability of coal dusts; the effect of the admixture of an incombustible dust with coal dust; and experiments on the relative inflammability of different coal dusts at Liévin. Three appendices deal, respectively, with the following subjects:—(1) The volatile constituents of coal; (2) the extraction of coal by pyridine; (3) analyses of coals and their relative ignition-temperatures.

From the results of the analyses contained in No. 1 appendix the Committee concludes that "all coals contain at least two different types of compounds of different degrees of ease of decomposition"; that coal "must be regarded as a conglomerate of which the degradation products of celluloses form the base and the changed resins and gums of the plants the cement"; that the latter are most readily decomposed by heat, yielding as gases mainly the paraffin hydrocarbons; that these are probably the substances which

[1] Second Report to the Secretary of State for the Home Department of the Explosions in Mines Committee. Cd 6431. (London: Wyman & Sons, Ltd., 1912.) Price 7½d. The illustrations which accompany the present article are from this report, and are reproduced with permission of the Controller of H.M. Stationery Office.

have been shown by Bedson to be extractable in considerable quantity from coal by the action of pyridine; and that the inflammability of any particular kind of coal dust depends more upon the proportion of paraffin-yielding substances contained in it than upon that of its volatile matter considered as a whole.

The apparatus employed by the Committee for ascertaining the temperature of ignition of different kinds of coal dust resembles that previously employed for the same purpose by Bedson and Widdas, and by Taffanel, in so far that, in each, a small cloud of fine dry dust (1 or 2 grams) is projected by a puff of air into a tube, or closed space, in which it is raised to the temperature of ignition by coming more or less closely into contact with an electrically-heated surface or spiral of platinum wire. Bedson and Widdas had no means of measuring the temperature of ignition

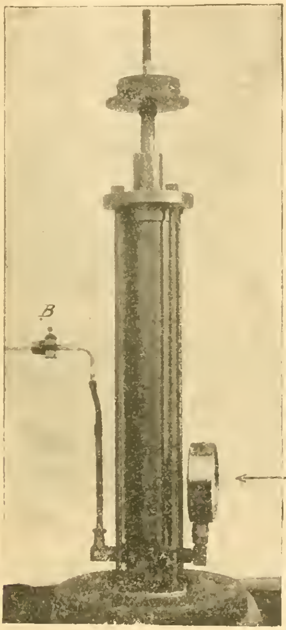

FIG. 2.—Apparatus for giving a constant puff of air.—A brass cylinder 65 cm. long and of 11 cm. internal diameter is fitted with a weighted piston. For the experiments, the weight employed is such as to give a pressure of 2 lbs. per sq. in.

directly, but hoped to determine it by calculation from the varying number of amperes required to effect ignition with different kinds of dust. In this they were disappointed in consequence of the alteration which the coil of platinum wire underwent owing to the adhesion of particles of dust to it. Taffanel and the Committee, on the other hand, both measure the temperature by means of a thermo-couple. It will be sufficient, for present purposes, to describe the appliances used by the Committee.

The puff of air is produced by opening a stopcock *B*, Figs. 1 and 2, in a tube one end of which communicates with the interior of a vertical brass cylinder at its bottom end. The cylinder, which is 65 cm. long by 11 cm. in diameter, is provided with a weighted piston, which gives a pressure of 2 lb. per sq. in. to the air in its interior. The other end of the tube with the stopcock is connected to a larger tube A (Fig. 1), 2·5 cm. in diameter by 45 cm. long, in which a charge of about 2 grams of sieved and dried dust is laid along the bottom. The latter tube is supported near the upper side of a third horizontal glass tube, 8 cm. in diameter by 140 cm. long, open at both ends, as shown. A thin-walled quartz tube of capillary bore, with a platinum coil of 32 gauge wire, 17 mm. long by 1·5 mm. in diameter, closely wound upon its outside, and with a platinum and platinum-rhodium thermo-couple passing through it, extends horizontally across a diameter of the larger tube at a point 40 cm. from one end. The thermocouple is connected to a mille-voltmeter calibrated to read to temperatures on the Centigrade scale. The cross-section in Fig. 1 shows the disposition of the various connections and the position of the platinum spiral. By the adjustment of an external resistance the coil can be heated to any desired temperature up to 1400° C.

If ignition takes place freely when the dust-cloud is puffed into the combustion tube, the temperature of the coil is lowered 10 or 20 degrees, and another trial made, and so on, until the dust-cloud does not ignite. The mean of the two last observations is then taken as the ignition-temperature.

The following observations regarding the dust of a coal (224 N) containing 2·11 per cent. moisture, 35·70 per cent. volatile matter, 59·99 per cent. fixed carbon, and 2·20 per cent. ash, which was passed through a 240 mesh sieve, and dried for an hour at 107° C., may be given as an illustration of the method of finding the temperature required :—

Temperature of platinum coil.	Result.
1040° C.	Ignition. Flame propagated rapidly to end of tube.
1020° C.	Ignition. Slow propagation of flame.
1000° C.	No ignition.
1010° C.	No ignition. A few sparks round coil.

Ignition-temperature, 1015° C.

Fig. 3 shows two photographs of the flames produced in this apparatus.

A table on p. 9 gives the relative ignition-temperatures of a number of different dusts the total volatile matter of which, calculated on ash-free dry coal, varies from 41·77 per cent., with an ignition-temperature of 1065° C., to 26·02 per cent., with an ignition-temperature of 1095° C. The intermediate results are so incongruous amongst themselves that the Committee can discover no relationship between the percentages of volatile matter and the ignition-temperatures.

On the other hand, a similar table on p. 10, which gives the percentage extracted by pyridine, shows also that while the dust of one coal with a total proportion of volatile matter amounting to 32·14 per cent., and a percentage of 37·9 extracted by pyridine, ignites at a temperature of 1005° C., that of another, containing 36·3 per cent. of volatile matter, and a percentage of only 22·1 extracted by pyridine, requires a temperature of 1090° C. to produce ignition.

While fully alive to the fact that the relationship between ignition-temperature and percentage extracted by pyridine cannot be expected to hold rigidly, the Committee is of opinion that the results obtained up to the present are encouraging, and intends to continue the investigation on the same lines.

In the experiments on mixtures with a coal dust the ignition-temperature of which was 1005° C. when pure (passed through a 240 mesh sieve and heated to 107° C. for an hour), it was found that with 80 per cent. coal dust and 20 per cent. shale dust the ignition-temperature was 1095° C.; with 80 per cent. coal dust and 20 per cent. calcium carbonate, 1095° C.; and with 96 per cent. coal dust and 4 per cent. sodium bicarbonate, 1095° C., and similarly with smaller percentages of the inert substances.

M Taffanel's apparatus, experiments, and conclusions are described in the "Cinquième série d'Essais sur les Inflammations de Poussières," published in August, 1911, but space fails us to do more than mention them in this place.

Appendix I. is an abridgment of two papers—by Dr. Wheeler and M. J. Burgess—contained in vol. xcvii. and vol. xcix. of the Transactions of the Chemical Society, which deal with the destructive distillation of coal and the products evolved from it at different temperatures. Appendix II. is a description of the method of extracting those matters contained in coal that are soluble in pyridine, by means of a Soxlet fat-extraction apparatus, of which an illustration is given. Appendix III. is a table of analyses (ultimate and proximate) of forty-six different samples of coal. It also contains the percentage (on ash-free dry coal) extracted by pyridine, and the relative ignition-temperature of each.

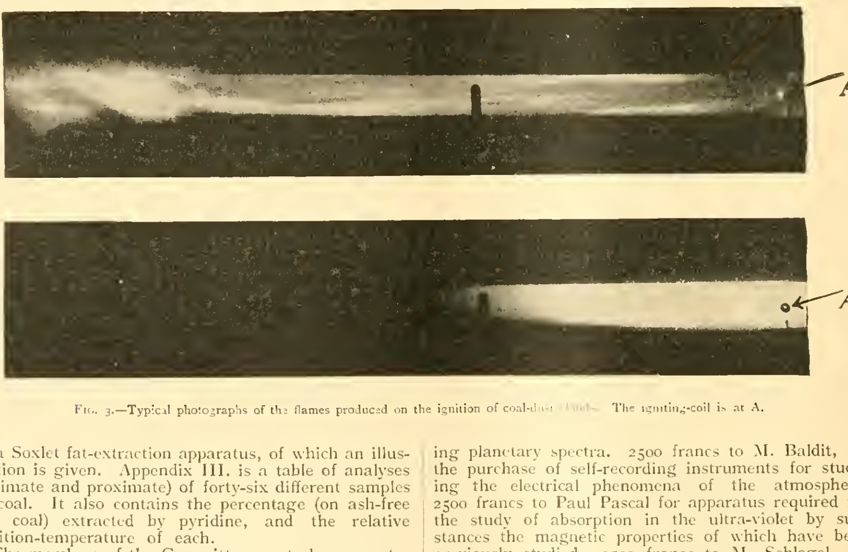

FIG. 3.—Typical photographs of the flames produced on the ignition of coal-dust [illegible]. The igniting-coil is at A.

The members of the Committee are to be congratulated on the ingenuity displayed in the construction of the apparatus for ascertaining the ignition-temperature of more or less combustible dusts. The results of their experiments, as well as those of M. Taffanel in the same direction, are, in themselves, exceedingly interesting, and may, in some as yet occult manner, tend towards the prevention of colliery explosions. They would undoubtedly be of service if an attempt were made, at any time, to classify mines according to the more or less inflammable nature of the coal dust produced in them. But as the attempt to do this in Germany led to disastrous results in the case of at least one mine[2] in which the coal dust was supposed to be innocuous, the experiment is obviously a highly dangerous one.

W. GALLOWAY.

[2] Carolinenglück, February 17, 1898: 116 killed.

THE BONAPARTE FUND OF THE PARIS ACADEMY OF SCIENCES.

THE committee of the Paris Academy of Sciences appointed to deal with the distribution of the Bonaparte Fund for the year 1912 has made the following recommendations, which have been accepted by the academy:—3000 francs each to MM. Louis Gentil, Pallary, J. Pitard, and Bouguil, members of the scientific expedition to Morocco. This expedition will undertake geological, zoological, botanical, and agronomical researches with a view to the future development of the country. 3000 francs to Prof. de Martonne and his fellow-workers, Jean Brunhes and Émile Chaix, for assisting the publication of a collection of morphological documents, entitled "Atlas Photographique des Formes du Relief Terrestre." 3000 francs to Louis Dunoyer for the construction of apparatus for the complete study of absorption and fluorescence spectra of the alkali metals. 3000 francs to M. Hamet, for collection of material for his work on the Crassulaceæ. 2500 francs to M. Bosler for the purchase of a prism of large dispersion for studying planetary spectra. 2500 francs to M. Baldit, for the purchase of self-recording instruments for studying the electrical phenomena of the atmosphere. 2500 francs to Paul Pascal for apparatus required for the study of absorption in the ultra-violet by substances the magnetic properties of which have been previously studied. 2500 francs to M. Schlegel, for assistance in his work on some Crustacea. 2000 francs to M. Sauvageau, for assistance in his studies on the distribution of the Cystoseira. 2000 francs to M. Welsch, to assist him in the continuation of his geological work. 2000 francs to M. Bierry, to defray the expenses of his proposed work on the metabolism of the carbohydrates. 2000 francs to Dr. Mawas, to allow him to continue his experiments on the mechanism of the accommodation of the eye. 2000 francs to M. Gruvel, to assist him in his exploration of the bay of Lévrier from the zoological, oceanographical, and geographical points of view.

Awards from this fund are not given as prizes for completed work, but are given to workers of proved competence for assistance in carrying out definite researches.

THE WEATHER OF 1912.

THE almost complete absence of summer weather and the frequent rains at almost all seasons have rendered 1912 memorable. The bad weather was more noticeable by contrast with the magnificent weather of 1911. The summer contrast for the two years was dealt with in NATURE for September 19, 1912, pp. 71–73.

LONDON RESULTS.

1912	Temperature Means: Max.	Min.	Max. and Min.	Diff. from average	Days above average	Frosty nights	Rainfall: No of rainy days	Total fall In.	Diff. from average In.	Sunshine: Daily mean Hours	Diff. from average Hours
January .	44·9	36·0	40·4	+2·0	19	8	18	3·03	+1·15	0·89	−0·51
February	48·6	38·6	43·6	+3·8	23	7	21	1·73	+0·25	1·33	0·78
March .	53·3	40·5	46·9	+4·4	26	1	19	2·58	+1·06	2·97	−0·39
April . .	59·8	39·4	49·6	+1·5	17	2	2	0·04	−1·53	7·47	+2·44
May . .	67·5	46·5	57·0	+3·2	24	—	12	1·29	−0·63	6·15	−0·26
June . .	69·5	49·3	59·4	−0·9	11	—	18	2·35	+0·31	7·29	+0·81
July . .	74·9	54·4	64·6	+0·9	15	—	11	1·24	−1·16	5·34	−1·91
August .	66·7	50·1	58·4	−4·5	1	—	26	4·27	+1·93	3·69	−3·09
Sept. .	60·8	46·5	53·7	−4·5	4	—	5	2·11	−0·04	3·96	−1·26
October .	57·1	39·3	48·2	−2·2	9	2	14	1·88	−0·90	3·96	+0·88
Nov. .	48·3	39·3	43·8	+0·4	17	6	16	1·55	−0·67	0·89	0·83
Dec. . .	50·5	40·7	45·6	+5·8	26	2	21	2·82	+0·99	0·86	+0·07
Year .	58·5	43·4	50·9	+0·8	192	28	183	24·89	+0·76	3·73	−0·40

The Greenwich observations given in the foregoing table are taken from the reports of the Meteorological Office. The mean temperature for the year is 50·9°, which is 0·8° in excess of the average. From June to October inclusive July was the only warm month. In both August and September the deficiency was 4·5°, and in the two months combined there were only five warm days. December, with the mean of 45·6°, was 5·8° in excess of the average. There have only been two Decembers since 1841 with a higher mean; these were 46·2° in 1852, and 45·8° in 1868. The excess of temperature in March was 4·4°, and the month in some districts was the mildest during forty years. There were only twenty-eight days with frost during the year.

The wettest months of the year were August, January, December, and March. There were only five days without rain in August, and only ten dry days in December. The driest month was April, with a total rainfall of 0·04 in., and at some places in the south-east of England the month was rainless.

The year's sunshine was 1364 hours, and the sunniest month was April, with a duration of 225 hours, which is 85 hours in excess of the average, and it was double the duration registered in August, which, with its 114 hours, was the least sunny month of any from April to October inclusive.

The summary for the year given by the Meteorological Office from the results for the fifty-two weeks ended December 28 shows that the greatest excess of rain in any district was 9·57 in. in the south-west of England, whilst in all the English districts, except the north-west, the excess was more than 5 in. The west of Scotland was the only district with a deficiency of rain, and there it was less than an inch short of the average. The duration of bright sunshine was deficient over the entire kingdom; the greatest deficiency amounted to 0·9h. per day for the year in the north-east of England, and 0·8h. per day in the east of Scotland, the south-west of England, the south of Ireland, and the Channel Islands.

CHAS. HARDING.

SCIENCE TEACHING IN PUBLIC SCHOOLS.[1]

IN the period of more than sixty years during which I have watched the progress of education in this country, no feature seems to me to stand out more prominently in that progress than the entrance and establishment of science in a recognised place in the tuition of our public schools. At the beginning of the period the teaching of even the rudiments of a knowledge of nature formed no part of the ordinary curriculum of study. Here and there, indeed, there might be found an enlightened headmaster or other teacher who, impressed with the profound interest and the great educational value of the natural sciences, contrived to find time amid his other duties to discourse to his pupils on that subject, and sought to rouse in them an appreciation of the infinite beauty, the endless variety, the ordered harmony, and the strange mystery of the world in which they lived. He might try to gain their attention by performing a few simple experiments illustrative of some of the fundamental principles of physics or chemistry, or by disclosing to their young eyes some of the marvels which they might discover for themselves among the plants and animals of the countryside. Such broad-minded instructors, however, were rare, and were far ahead of their time.

There were then no special science teachers, no school laboratories, no proper school museums. The range of instruction in the public schools still lay within literary lines, pretty much as it had existed for centuries; excellent, indeed, so far as it went, but somewhat out of date, and no longer in keeping with the modern advance of knowledge and culture all over the world. Boys left school, for the most part, profoundly ignorant of nature, save in so far as they had been able to pick up information by the way, from their own observation, reading, or reflection. At the universities they fared little better. Chairs for the cultivation of various branches of science had indeed been founded there. But the duties of the professors were usually considered to consist chiefly or solely in the delivery of lectures, which were sometimes dull enough, and, where not required in reading for degrees, would attract but scanty audiences. An enthusiastic or eloquent professor might gather around him a goodly company of listeners as, in geology, Buckland used to do at Oxford and Sedgwick at Cambridge. But the laboratory work and experi-

[1] From the presidential address delivered to the Association of Public School Science-masters on January 8 by Sir Archibald Geikie, K.C.B., Pres.R.S.

mental demonstrations, now admitted to be so essential, had scarcely begun to be instituted in the universities. Lord Kelvin's famous physical laboratory, one of the earliest institutions of the kind in this country, was started by him only about the year 1850, and that of his friend Tait at Edinburgh some years later.

But the discoveries of modern science last century and the far-reaching effects of their practical applications in everyday life were arousing rapidly increasing attention in the community. Natural knowledge was seen to be both of supreme interest in itself and of paramount importance on account of the many ways in which it could minister to the welfare of man. It was impossible that education could long remain unaffected by this widespread appreciation. Alike on the schools and on the universities the force of public opinion began to make itself felt. Ere long a momentous step was taken by a Royal Commission which was appointed to inquire into the public schools, and which, in its report, "strongly recommended the introduction and fostering of natural science in these schools." The Public Schools Act, which embodied the recommendations of the Commission, was passed in 1868, and may be regarded as marking the definite starting point of this great reform.

Of course, the adoption of science teaching in the public schools has not everywhere made the same progress throughout the country. As was to be expected, it has been unequal, depending as it did on the disposition of the authorities at each school, as well as on the accommodation and funds available. In one or two schools the position of science is perhaps nearly as good as is at present required, and the rest are gradually improving. Everywhere the spirit of compromise and amity has prevailed, and there seems to be on all sides a general desire to meet the requirements of the science side, so far as the circumstances of each school will permit.

If from the schools we turn to the universities, we see that the advance of the provision for the sciences has there been still more rapid. Not only have the older seats of learning widened their range of studies and largely increased the facilities for scientific research, but newer universities have sprung up in different centres of population, with the dominant purpose of developing scientific training and promoting the prosecution of original investigation. As a further and significant proof that the community at large has awakened to the importance of making natural science one of the branches of education, we must also take account of the multiplication of secondary schools having a scientific element, and the rise of technical schools and colleges.

This retrospect of the past half-century and the outlook which it discloses for the future cannot, I think, be contemplated without considerable satisfaction by the reasonable advocates of science who are not swayed by an inborn spirit of iconoclasm. The advance which has been made may not have been as rapid as these reformers desire, or as we all hoped for. But it has been real, it is still in progress, and we may believe that it will now advance more equally and rapidly over the whole country.

But while I am of opinion that we have cause to rejoice over what has already been accomplished, I do not wish to draw too roseate a picture of the present state of the science teaching in this country, or of the position and prospects of the science-masters. I well know that these teachers are in many cases confronted with serious difficulties which hamper them in their work. They are, so to say, newcomers into the educational system of the country, and the subjects which they teach have consequently neither the prestige nor the position held by the long-established literary studies. Such a state of matters is obviously one that can only be changed by the lapse of time, and let us hope that this lapse will not be prolonged. In the meanwhile, the science-masters, straining every nerve to make their teaching effective, will, by their success in kindling a love of science among their pupils and demonstrating the educational value of their teaching, take the most effectual way to establish the position of science and to further their own claims for consideration.

The necessity of providing several science-masters, where circumstances permit, raises the difficulty of finding places for them in the already crowded time-table of the school. This is undoubtedly a very serious problem. Each of the various subjects taught contends for what is thought adequate time. And in this competition undoubtedly the older subjects in the curriculum, being already in possession, and having strenuous defenders, are at a considerable advantage over those which have been recently introduced. But the difficulty is one which, in the hands of a sympathetic headmaster and with a spirit of goodwill among the members of his staff, ought not to be insuperable. Even without the curtailment or abandonment of any of the studies already in the field, it should be possible by tactful rearrangement to secure at least the time demanded for the minimum amount of science teaching which is indispensable. In my opinion this minimum should ensure that every boy at a public school shall be given the opportunity of obtaining a broad general idea of the scope and bearings of natural science and of having his apprehension stirred with regard to the manifold interest and charm of nature. This end cannot be properly attained by lectures alone, though these, from an inspiriting teacher and well illustrated with experiments or demonstrations, are invaluable. They require, however, to be supplemented with practical work by the pupils, wherein they can themselves handle apparatus, and thus gain a far more vivid and lasting knowledge of physical and chemical laws and processes than can be acquired in any other way. They must also learn the fundamental elements of biology and geology, studying not only with the teacher in the class-room, but with specimens of plants and animals in the laboratory or museum, and where possible in the field.

The true educator, no matter in what branch of discipline he may be engaged, is not a man whose chief aim is to cram into the minds and memories of his pupils as ample a store of knowledge as these will hold, and whose success is to be judged by the results of competitive examinations. If this is true on the literary, it is not less so on the scientific side. And on the latter the temptation to teach in that unfruitful way is probably greater than on the former. I have known more than one teacher of science possessing a wide acquaintance with his subject, yet quite incapable of making use of it as a stimulating educational instrument. Full of details, he would pour them forth in wearisome iteration, without the guiding thread of logical sequence that would have linked them intelligibly and interestingly together. Men who have within them no store of living fire are hopelessly incompetent to elicit any spark of it in their listeners. I hope such men are rarer now than they were in my younger days. If they have not passed with the dodo and the gare-fowl into the domain of extinct creatures, they should be zealously kept out of our public schools.

In all the educational world I can think of no task more delightful to undertake than that of the science-master. At the same time there are few which demand so wide a range of qualifications. To reach the highest success in his calling the science-master must, of course, be thoroughly versed in his subject, alike theoretically and practically. He should, if possible, be a man who has himself done some original research, or at least is intimately familiar with methods of experimentation and investigation, and able to guide his pupils along the lines of independent research. I am strongly of opinion that his efficiency will be much augmented if he has had a good literary as well as a scientific training. When he enters on his teaching career he will soon find the great advantage of a cultivated style, both in discoursing and in writing. Unfortunately some able men of science who have neglected the literary side of their education cannot arrange their thoughts in proper sequence or express them with clearness and terseness. I would urge the science-master to keep his hold on literature, ancient as well as modern. Many a time when weary with his labours, and discouraged, perhaps, by the difficulties wherewith they are beset, he will find in that delightful field ample consolation and refreshment.

But, above all, the science-master must be thoroughly in love with his subject and possess the power of infusing some of his affection for it into his pupils. His evident and genial enthusiasm should be infectious and become an inspiration that appeals to his boys in everything he does, whether as he lectures and demonstrates to them in the class-room or as he shows them how to work in the laboratory. There are probably few other callings in the educational domain where the personal touch, the stimulating influence that springs from earnest devotion to a subject, has so many opportunities of manifesting itself and tells more promptly and powerfully on the pupils. The teacher who is gifted with such an inspiring power may do more in the way of developing a love of science with the meagre outfit of a parish school than a man without this influence can do with all the resources of a modern laboratory.

RADIATIONS OLD AND NEW.[1]

WHEN, therefore, X-rays are projected into any material we must think of them as a stream of separate entities, each one of which has complete independence of its neighbours and pursues a life of its own. It changes to a β ray and back again; as a β ray it is liable to loss of energy and much deflection, so that those rays which do not pass through the body but are held therein end as electrons moving about in the body with the velocities of thermal agitation; that is to say, with those velocities which free electrons in the body must possess on account of the share which they take in carrying the heat of the body.

Now we may ask ourselves what will be the result if transformations continue to take place at these lower energies; for the moment let us assume that they do. Let us consider some substance like a block of metal. Within it we know that there are innumerable electrons travelling to and fro with various speeds. In their motion is stored up energy; the communication of heat to the body makes them dance more quickly. When the quicker motion is begun in one part of the body, diffusion hands on the motion to the rest; that is to say, heat has been conducted through the body. If we try to pass an electric current through the body, it is the movement of the electrons that constitutes the current. This is the accepted theory at the present time. It is even possible—but this is not accepted by all—that the energy of the moving electrons in the body constitutes the main store of heat therein. The electrons do not all move at the same speed, of course; but there is a certain well-known distribution of their energies about a mean value. At any time a certain percentage of the electrons are moving with speeds lying within definite limits, although the individuals possessing such speeds are continually changing. If we now take into account the transformations of which I have been speaking, we find that there must be X-ray quanta—this name will do for them as well as any others—in such numbers as to be in equilibrium with the electrons of every variety of speed. In the case of the X-rays and electrons which we have been handling in our experiment, we find that the greater the energy the larger the number of X-ray quanta required to be in equilibrium with the corresponding electrons, for quanta of large energy are transformed into electrons much more rarely than quanta of small energy, whereas electrons of large energy are transformed as often, and perhaps more often, than those of small energy. Thus the distribution of energy amongst the quanta is not the same as the distribution amongst the electrons; in the former there is a much larger number—relatively—of the quanta of larger energy.

The electrons which we are considering have very little power of penetration or of breaking away from the substances in which they are. At high temperatures, when they move more quickly, there is a considerable emission, an effect which has been much studied recently. But at ordinary temperatures the emission of electrons is small. Recently R. W. Wood has suggested that there must be an "aura" of electrons surrounding a conductor and extending a minute distance away, since only in this way can we account for the fact that electricity passes freely from one conductor to another when they are separated by a space of the order of a wave-length of light. But if the electrons have such difficulty in breaking away from a substance, this is not true of the X-ray quanta. If they behave like those we have been investigating of recent years, they have far greater powers of penetration than the electrons, and every body must be emitting them in streams. Moreover, if bodies be placed near each other, there will be an interchange which will hand energy from one to the other until there is an equilibrium. If a hot body is placed near a cold one, the former contains some electrons and corresponding quanta of great energy, and as these stream over to the cold body, they go through transformations which permit of loss of energy, since for a time they put the energy into electron carriers which can exchange, and do exchange, energies with others—through the mediation of the atoms, it may be. X-ray quanta have not that power of themselves. Thus in time the two bodies are brought to the same temperature.

In this way we have a conception of radiation which on the surface differs from that which is ordinarily held. But does it do so really? May it be that we have merely found a different method of regarding the processes of radiation? If so, that would be a very good thing, for it is one of the best aids to inquiry to have more than one hypothesis which will link together a number of experimental facts. Nor need we be afraid if the hypotheses differ considerably. On the contrary, that means that we have the greater number of interesting things to discover between the two points of view and their final point of convergence.

Now we know that when light falls upon material substances there is an emission of electrons of slow speed; in other words, light radiation resembles

[1] Evening discourse delivered on September 6, 1912, before the British Association at Dundee by Prof. W. H. Bragg, F.R.S. Continued from p. 532.

X-radiation in one important particular. Investigators have gone further. They have shown with considerable probability that the velocity of the ejected electron varies with the wave-length of the light; the shorter the wave-length, the swifter the electron. Moreover, there are lines of reasoning, worked out in great detail by Planck, Einstein, and others, which lead to the thought that light energy is contained in separate quanta; the shorter the wave-length, the more energy in the quantum. This is one of the most remarkable developments of modern physics.

It seems as if there was a strong invitation to consider radiation from this point of view. We ought not to think that in doing so we abandon the wave theory or its electro-magnetic development. Rather we might say that the radiation problem is too great to be seen all at once from any point to which we have hitherto attained, and that it is to our advantage to look at it from every side.

It would be quite fair, moreover, to say that there is something after all in the corpuscular theory of light. There is a very great deal of evidence, as I have already indicated briefly, for a corpuscular theory of X-rays; and it is widely held that the two forms of radiation are akin to each other. How can we hold a corpuscular and a wave theory of light at the same time?

If we say that radiation consists in the emission of quanta, each of which traverses space without spreading or altering in any way, and label this a corpuscular theory; and if, on the other hand, we suppose light to consist of wave-motions, and that we can resolve such wave-motions at any one time into elements each of which might exist alone and would then spread through space like a ripple on a pond; and if we say that the quantum in the one theory is to be matched with the element in the other, then, of course, the two theories are inconsistent.

But such inconsistencies are difficulties of our own making. If one hypothesis links together a number of observed facts, and a second hypothesis a somewhat different number; and if we think the two are inconsistent, the fault must be ours. We must be stretching one or other hypothesis to breaking-point, and we must work in the hope of finding a new hypothesis of greater compass. Until we do so, we are right to use those which are more limited; it is the way of scientific advance. So the great men of the past have done, as we may see readily.

Let us go back to the discussions of the close of the seventeenth century, the time when Newton, Huygens, Hooke, Pardie, and others debated the nature and form of light. A very important discovery had recently been made by Romer, who had shown by astronomical observations that light, which brought the news of the events taking place in space, took time to bring it; in others words, that light had a velocity. Romer had even succeeded in measuring the velocity with fair accuracy. Now Descartes had supposed the propagation of light to be instantaneous. He had considered it to be a pressure transmitted across a plenum between the luminous object and the eye; according to a well-known image, vision resembled the process by which objects are made manifest to a blind man, who feels for them with his stick and receives pressures transmitted thereby. Apart from the direct proof by Romer that this view was wrong, a very interesting objection to it is given by Huygens, who, after stating the Cartesian theory, remarks that "it is impossible so to understand what I have been saying about two persons mutually seeing one another's eyes, or how two torches can illuminate each other." That is to say, it is impossible to explain on a simple pressure theory the perfect facility with which rays of light traverse each other without injury. This mutual traverse of light rays interested Huygens exceedingly, and, as we shall see, influenced materially his choice of the hypothesis in terms of which he expressed the facts known to him.

Thus Newton and Huygens were led to introduce the idea of motion of some sort of matter as a fundamental point in their theories. They did so in different ways; and the distinction grew to be a cleavage between two schools of thought. It was not a very deep distinction at first; it would have been easy to have stepped from one side to the other of the dividing line. Only in later times did the corpuscular and wave theories stand immovable in hostile antagonism. It is not at all impossible that modern research will once more draw the two theories together.

The difference may be put in this way:—Newton imagined light corpuscles which moved in straight lines from the source of light to the recipient. thought that the "light" had the same carrier from beginning to end of its path. We should now express his idea by saying that the "energy" of the light had the same carrier; but Newton did not, of course, conceive of light-energy as a quantity to be measured and discussed. How far he was from this more modern idea is instanced by his supposition that the radiating power of the sun was conserved by the mutual radiation of its parts.

On the other hand, Huygens imagined the light to be passed on from particle to particle of the æther; that is to say, the energy was not carried by one particle all the way, but by relays. It must be remembered that he thought of the æther as a collection of particles resembling the particles of luminous bodies, but of smaller dimensions. The latter particles he supposed to float in a subtle medium which agitated them and made them strike against the particles of the æther, which thus became the seat of spreading impulses. We might compare the difference between the ideas of Newton and Huygens with the difference between the despatch of a message by a special runner and the spreading of a rumour.

Huygens has given two reasons for his choice of hypothesis: one, the extreme speed of light, which Romer had recently found; the other, the ease with which rays of light traverse each other. These induced him to reject the idea of the movement of matter through the whole of the distance from source to receiver, since he could not imagine how matter could move with so great a speed, nor could he conceive how material rays could pass through each other. He arranged æther corpuscles in a row between source and receiver, and supposed light to move along the row in the same way that a disturbance would move along a row of glass spheres placed so as to touch each other. Indeed, he filled all space with æther particles in contact so as to allow of the transmission of disturbances from any one point to any other. In such a plenum two disturbances might easily be imagined to cross each other without hindrance. To use an illustration which he gives himself, "If against this row (B C in Fig. 10) there are pushed from two

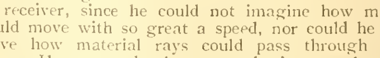

FIG. 10.

opposite sides at the same time two similar spheres A and D, one will see each of them rebound with the same velocity which it had in striking; yet the whole row will remain in its place, although the movement has passed along its whole length twice over." It is, of course, the movements, not the spheres, which traverse each other. Or we may arrange the experiment as in Fig. 11. If the balls A_1 and B_1 are pushed in the directions of the arrows so as to strike the rows they are shown approaching, the spheres A_3 and B_3 will spring forward and continue the lines of motion of A_1 and B_1, and the movements will have crossed each other without any injury. He conceived such a result to be beyond explanation on a theory like Newton's.

His hypothesis met also, as he thought, the other of the two fundamental requirements. The disturbance might be supposed to move as fast as was desired, even with the extreme velocity which light, according to Romer, possessed. For, as he says, "there is nothing to hinder us from supposing the particles of the æther to be of a substance as nearly approaching to perfect hardness and possessing a springiness as prompt as we choose." And another very important property of light was illustrated at the same time, viz., that the velocity in free æther was independent of the intensity.

It is to be observed that Huygens takes the ideas of hardness and impenetrability of matter which he has drawn from the behaviour of glass spheres and applies them to the molecules of the æther.

From what we have seen of the properties of the new rays we cannot allow Huygens any justification of the reasons which he gives for his preference for the wave theory. There were two, you will remember. In the first place, he supposed that matter could not move with so great a speed as light; yet you see that the α particles move practically as fast as he conceived light to move, and they are as material as anything else. Secondly, he argued that streams of matter could not interpenetrate each other; yet we see that atoms can pass through each other easily. Indeed, the more we consider the behaviour of the rays from radio-active substances, the more impossible appears the view that "particles" of any sort have boundaries which are limits to interpenetration. We see no reason for supposing that there is anything in the known universe which can retain a portion of space to its own exclusive use and forbid all strangers to enter therein.

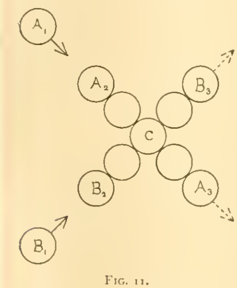

FIG. 11.

So the reasons which Huygens gives for his choice of a hypothesis are both mistaken; and we might think that this was a bad beginning for the structure which he built. But his true foundation was laid otherwise. The spreading-pulse theory suggested to him his famous construction of the wave front, which has been of such immense importance in the development of our knowledge of radiation. His construction gave a correct account of the phenomena of reflection and refraction, and, what was most wonderful, he found himself able to explain by its means the complicated motion of light in Iceland spar. In this way he began the marvellous development of the relations between light and crystalline structure which has roused the interest and admiration of the subsequent centuries. It is true that he had no idea of a regular succession of waves; in fact, he expressly states that he does not wish us to think of his pulses as following each other at regular distances. He did not explain colours, and he failed altogether to account for polarisation. But his hypothesis linked certain facts together, and was useful so far as it went.

It was Newton with his corpuscular theory who introduced the idea of periodicity in order to explain the colours of the soap film and other "thin plates"; who ascribed differences in colour to differences of frequency, and correctly described the phenomena of polarisation as due to the rays of light having sides, a description which could not be applied to the conception of Huygens. Newton was able to express many of the facts known to him in terms of vibrations of an all-pervading æther; he saw that in such case the longer vibrations would excite the sensation of red, and the shorter—the more refrangible—the sensation of violet. He actually supposed that such vibrations travelled along the optic nerves and carried the sensations to the brain, and he directed attention to persistence of vision as evidence of the "vibratory nature of the motions at the bottom of the eye." Heat he supposed to be conveyed by æther vibrations. He could express the behaviour of a soap film in respect to colour in terms of the wave theory with formal correctness, showing its dependence on the ratio between the thickness of the film and the wave length of light. But he preferred to express his ideas on a corpuscular model, because he could not otherwise explain the formation of sharp shadows, and deemed it impossible for a pulse on rounding a corner to spread so little as light. It was for this reason he rejected the theory of Huygens, and he was perfectly right. If we take Huygens's own model, if we project a billiard ball against a group of other balls in contact, as we might, somewhat inefficiently, start a game of pyramids, the energy of motion is scattered every way, and balls fly in all directions. Huygens never met this objection; it was not answered until the time of Fresnel, more than a hundred years afterwards. Newton was also impressed with the impossibility of varying the nature of light by transmission, reflection, or refraction, and ascribed all apparent changes of colour to sorting processes. As he says, "very small bodies conserve their properties unchanged in passing through several mediums, which is a condition of the rays of light." He was thinking of contemporaries who supposed that the colour of light was readily changed in deviation or transmission.

The essence of Newton's idea was the travel of light as an entity which did not spread or change as it went. He implied by the term "corporeity of light" no more than "something or other propagated every way in straight lines from luminous bodies without determining what that thing is, whether a confused mixture of difform qualities or modes of bodies, or of bodies themselves; or of any virtues, powers, or beings whatsoever." He strongly opposed a tendency to read more into his hypothesis than it was intended to hold. In these respects the X-ray resembles very closely the corpuscle which Newton conceived, so long at least as it remains untransformed. But if transformation occurs the electron generally loses energy, and a retransformed X-ray will have less energy than the original, a well-known process. It may be compared with the phenomenon of fluorescence, of which Newton knew nothing.

Now if X-rays are to be classed with light, as there are reasons for supposing, and as many do suppose with more or less conviction, then it must be acknowledged that Newton's conception has more value in it than the last century has been accustomed to grant. But we shall not therefore adopt Newton's theory as he left it. It is too obviously defective. It cannot explain diffraction, and his main reason for rejecting the wave theory was wrong. He gave no satisfactory explanation of the uniformity of the velocity of light in space. Even his explanation of the colours of thin films is defective. Moreover, he was hopelessly at sea, and, it may be observed, so was Huygens, in attempting to explain the absorption of light. Neither of them had at his command any mechanism but that of the collisions between particles of æther, particles of matter, and light corpuscles, and they could but juggle with the relative sizes of these things. Newton was very hard put to it to explain the difference between a perfectly transparent body and a perfectly black one, and was compelled to suppose it due to a small difference in the sizes of the particles of matter. Huygens would have liked to ascribe internal reflections at the surface of a piece of glass to collisions between the æther corpuscles and the particles of air outside, and was disconcerted by the fact that reflection took place equally well when there was no air at all. But it is quite unnecessary to follow the subject further, and discuss the contributions of Young and Fresnel, and the other men of famous names to whom the modern theories of radiation are due.

The point is simply this, that each of these great workers constructed for himself a hypothesis or model, which represented correctly certain facts known to him, and by its aid was able to use what he knew as a means to learn more. The results of his work depended upon the construction of his model, and his choice of the known facts he had made it to represent to a greater or less degree. For no one could construct a hypothesis which represented correctly all that was known. But if it was correct so far as it went it led to good results in a limited field.

Therefore it happens that hypotheses must always be diversified, and it is well for the possibilities of advance that they should be. If now we have a number of new facts regarding new radiations, if it turns out that they are to be carried over to the older radiations which have been studied for so long, and if the wave theory cannot absorb them at once, this means no rejection of the work of the past, no retracing of steps. It means rather the enriching of our opportunities of advance, in which all the good work which has been done in the past will tell as well as that which we may hope to do in the future.

If my observations are well-worn sayings, you will perhaps forgive the fact in the newness, and I should like to add, if I might, the appropriateness, of the illustration. It does, after all, make for our encouragement and efficiency if we remember that we are free to make any hypothesis we please, and that we are not to be judged directly for the choice we make, but indirectly for the use we make of it. Our reasons for choosing a scientific creed will probably be wrong; we cannot hope to do better always than Newton and Huygens. But perhaps we can do something with it which will be good and will last. It may contribute also to the general peace if we remember that our hypotheses are made, in the first instance, for our own personal use, and that we have no justification for demanding that others shall adopt the means which we find most convenient in the modelling of our own ideas.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The professor of anatomy has reappointed Dr. W. L. H. Duckworth to be senior demonstrator of human anatomy for five years from January 1, 1913, and Mr. D. G. Reid to be an additional demonstrator of human anatomy for the same period.

The Quick professor of biology has reappointed Mr. C. Warburton to be demonstrator in medical entomology as from October 1, 1912, to September 30, 1915.

The managers of the Balfour Memorial Fund give notice that the Balfour studentship will be vacant March 25. The names of applicants, together with such information as they may think desirable, should be sent on or before January 31 to the secretary, Prof. J. Stanley Gardiner, Zoological Laboratory, Cambridge.

OXFORD.—The master and fellows of University College intend to proceed, in the course of the Hilary Term, 1913, to the election of a fellow qualified to take part in the educational work of the college as prælector, with special reference to the chemistry schools, provided that a candidate suitable to the requirements of the college presents himself. Candidates must have taken a degree in a university of the United Kingdom or of the British Dominions beyond the Seas, and be unmarried. A stipend of at least 350*l.* per annum, including the emoluments of the fellowship, will be assigned to the fellow and prælector, so appointed, from the first, with prospective rise of salary proportionate to nature and length of service. The prælector in chemistry will not be precluded from undertaking further work in the University, outside the college, subject to the consent of the master and fellows from time to time. Candidates are requested to forward to the master of University College, on or before January 31, 1913, the following documents: (1) A signed application setting forth the candidate's qualifications, and any evidence (such, *e.g.* as original work) which he may desire to lay before the electors; (2) three, and not more than three, testimonials from independent sources in his favour.

PROF. R. M. BURROWS, professor of Greek in the University of Manchester, has been appointed principal of King's College, London, in succession to the Rev. Dr. A. C. Headlam.

THE fifth annual dinner of old students of the Royal College of Science, London, will be held at the Café Monico, Shaftesbury Avenue, on Saturday, January 25. The president of the Old Students' Association (Sir William Crookes, O.M., F.R.S.) will preside, and the guests will include Sir Alfred Keogh, K.C.B., Sir Henry Miers, F.R.S., Sir Robert Morant, K.C.B., Lieut.-Col. Sir David Prain, C.I.E., Sir Amherst Selby-Bigge, K.C.B., Dr. R. T. Glazebrook, F.R.S., and Dr. H. Frank Heath, C.B. Tickets may be obtained on application to Mr. T. Ll. Humberstone, secretary of the Old Students' Association, 3 Selwood Place, South Kensington, S.W.

THE recently established University of Hong Kong is making rapid strides in the development of its various faculties, and attention is at present being specially directed to the provision of facilities for the practical study of pure and applied science. In an address delivered to the Institution of Engineers and Shipbuilders of Hong Kong last November, Prof. C. A. M. Smith, professor of engineering in the new University, made an eloquent appeal to men of wealth to assist in the important work of training Chinese students in modern science. "In Hong Kong," he said, "we wish to train men who know the East to develop China's natural resources. For that development they must obtain machinery—if we do our work aright we shall secure a market for those who are at home, and provide greatly increased freightage for the shipping to this port." Later he continued:—"We require at once machines for demonstration and experimental purposes. We want to equip laboratories for testing the materials of construction, such as steel, concrete, copper, &c. We want oil, gas and steam engines, and refrigerators, as well as dynamos and all sorts of electrical apparatus." As an inducement to manufacturers and others to give generously, Prof. Smith said:—"We will house your gifts and keep your samples running and in good condition. We will show your present and future customers the merits of your machines, and we will advertise your goods in the centre of the greatest market of the near future." There seems every likelihood that Prof. Smith will be successful in his efforts to secure well-equipped laboratories of a modern type. Already, we understand, the Chloride Electrical Storage Co., Ltd., of Manchester, has decided to present to the University of Hong Kong a complete battery of their chloride accumulators for use in the electrical laboratory. It may be hoped that ere long each of the pieces of apparatus in the list needed at the new University, which has been circulated widely by Prof. Smith, will be secured.

SOCIETIES AND ACADEMIES.

London.

Mathematical Society, January 9.—Prof. A. E. H. Love, president, and temporarily Sir Joseph Larmor, treasurer, in the chair.—J. C. **Fields**: Proofs of certain general theorems relating to orders of coincidence.—W. E. H. **Berwick**: The reduction of ideal numbers.—A. E. H. **Love**: Notes on the dynamical theory of the tides.—W. H. **Young**: Uniform oscillation of the first and second kind.—H. **Bateman**: Some definite integrals occurring in the harmonic analysis connected with a circular disc.

Royal Astronomical Society, January 10.—Dr. F. W. Dyson, F.R.S., president, in the chair.—Dr. S. S. **Hough**: The periodic errors in the right ascensions of standard catalogues. In giving an account of this paper, Sir D. Gill explained in detail the method adopted at the Cape Observatory for obtaining great accuracy in meridian observations, notwithstanding some instability in the foundations of the instruments.—Prof. **Douglass** spoke on the records of solar radiation made in Arizona.—H. E. **Wood**: Work at Union Observatory, Transvaal, and photographs of Gale's comet. The comet had two straight tails, one of them of considerable length.—Rev. A. L. **Cortie**: Sun-spots and terrestrial magnetic phenomena, 1898–1911. Second paper, the greater magnetic storms. It was concluded that while a general state of sun-spot activity corresponds with a general state of terrestrial magnetic activity, it requires the advent of a large spot, the influence of which extends in all directions, or a spot favourably situated in heliographic latitude, to disturb the equilibrium by the precipitation of a magnetic storm.—Prof. H. C. **Plummer**: The motions and distances of the brighter stars of the type B–B5, being a continuation of previous researches on stellar motions. The whole of the stars of the first type appear to be at about 200 light-years' distance, and to be very uniformly distributed in a plane, their motions being parallel to the Milky Way. The author considered that there were two star streams.—Mr. Eddington pointed out that the motions of the B-type stars were very small, and that they might be moving in a direction perpendicular to the Milky Way.—C. **Martin** and H. C. **Plummer**: The short-period variable SU Cygni. Prof. Plummer showed a diagram of the interesting light-curve of the star.

Paris.

Academy of Sciences, December 30, 1912.—M. Lippmann in the chair.—H. **Deslandres**: The general magnetic field of the upper layers of the solar atmosphere. New verifications. Regarding the upper solar layer as strongly ionised, the behaviour of the ions in a magnetic field offers a simple explanation of the phenomena hitherto observed. Further experimental proofs are given.—A. **Haller** and Édouard **Bauer**: The formation of dimethylstyrolene, starting with phenyldimethylethyl alcohol. The alcohol was obtained by the reduction of phenyldimethylacetamide with sodium and absolute alcohol. Various by-products of the reaction are described.—The secretary announced the death of Paul Gordan, correspondant for the section of geometry.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the third quarter of 1912. The results of observations made on seventy-two days are given in tabular form.—M. **Luizet**: Elements of the orbit of the variable star RR Lion (BD+24·2183°).—Ch. **Gallisot**: The influence of the colour and magnitude in sudden variations of brightness of a stellar image. An account of a repetition of some experiments of Broca and Sulzer, for the case of luminous points.—Georges **Rémoundos**: The theory of M. Picard and algebroïd functions.—J. **Taffanel** and H. **Dautriche**: The detonation of dynamite No. 1.—G. **Eiffel**: The resistance of spheres in air in motion. An experimental study of the causes of the divergence of the author's results and those obtained at the aërodynamical laboratory at Göttingen. In the expression, $R=KSV^2$, in which R is the total resistance, S the diametral surface, V the velocity of the air, and K a constant, K is only really constant after a certain critical value of V has been reached. In the Göttingen experiments V was below this critical value. The existence of this critical velocity is of practical importance, and must be taken into account in apparatus used to measure the velocity of the wind, or of aëroplanes.—René **Arnoux**: A new method of steering aëroplanes by means of the motor.—Gustave **Plaisant**: A mode of cycloidal attack of the air.—A. **Korn**: The potentials of an attracting volume the density of which satisfies the Laplace equation.—F. **Croze**: New observations relating to the Zeeman phenomenon in the hydrogen spectrum. The author's experimental results are not in accord with those recently published by Paschen and Back. An account is given of further experiments on the cause of these discrepancies.—Guillaume de **Fontenay**: The action of inks on the photographic plate. The action is complicated, and varies greatly with the method of working.—Ch. **Boulanger** and G. **Urbain**: The theory of efflorescence. The influence of the magnitude of the crystal. An expression is given for the rates of loss of moisture of two crystals of different masses of the same material, and this is submitted to experimental confirmation with a special form of microbalance.—André **Brochet**: The relation between the conductivity of acids and their absorption by hide powder. The acid absorption is a general phenomenon, and is due to a chemical combination, since whatever acid is employed the amount absorbed is sensibly proportional to the chemical equivalent.—Jean **Bielecki** and Victor **Henri**: The quantitative study of the absorption of the ultra-violet rays by fatty acids and their isomeric esters. The absorption of ultra-violet rays by acids and esters is not determined by their empirical formula. It depends on the constitution of the molecule.—H. **Labbé**: The influence of alkaline salts on the elimination of urinary ammonia in normal dogs.—Michel **Cohendy** and D. M. **Bertrand**: Living sensibilised antistaphylococcus vaccine.—A. **Trillat** and F. **Mallein**: Study of the action of the filtrate or distillate of a fresh culture of *B. proteus* on the evolution of the disease caused by pneumococcus in mice.—E. L. **Trouessart**: Migrating and sedentary forms in the ornithological fauna of Europe.—Louis **Besson**: A periodic element in the variations of the barometer.

BOOKS RECEIVED.

The Milk Question. By Prof. M. J. Rosenau. Pp. xiv+309. (London: Constable and Co., Ltd.) 7s. 6d. net.

Introduction to the Rarer Elements. By Dr. P. E. Browning. Third edition. Pp. xiii+232. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd.)

Willing's Press Guide, 1913. Pp. xii+487. (London: J. Willing, Ltd.) 1s.

Weather Bound. By R. T. Smith. Pp. 320. (Birmingham: Cornish Bros., Ltd.) 15s. net.

The Value and Destiny of the Individual. The Gifford Lectures for 1912, delivered in Edinburgh University. By Dr. B. Bosanquet. Pp. xxxii+331. (London: Macmillan and Co., Ltd.) 10s. net.

Handbuch der Entomologie. Edited by Dr. C. Schröder. Lief. 1 to 3. (Jena: G. Fischer.) 5 marks each.

Das Bodenwasser und die Abkühlung des Meeres. By F. Nansen. Pp. 42. (Leipzig: Dr. W. Klinkhardt.)

The Sea West of Spitsbergen. The Oceanographic Observations of the Isachsen Spitsbergen Expedition in 1910. By B. Helland-Hansen and F. Nansen. Pp. 89+plates vi. (Christiania: J. Dybwad.)

Finländische hydrographisch-biologische Untersuchungen No. 10 Jahrbuch, 1911, enthaltend hydrographische Beobachtungen in den Finland umgebenden Meeren. Edited by Dr. R. Witting. Pp. 129+4 plates. (Helsingfors.)

Plant Diseases. By Dr. W. F. Bruck. Translated by Prof. J. R. Ainsworth-Davis. Pp. 152. (London: Blackie and Son, Ltd.) 2s. net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 16.

ROYAL SOCIETY, at 4.30.—The Effect of Junctions on the Propagation of Electric Waves along Conductors: Lord Rayleigh.—The Influence of Chemical Constitution upon Interfacial Tension and upon the Formation of Composite Surfaces: W. B. Hardy.—Duration of Luminosity of Electric Discharge in Gases and Vapours: Hon. R. J. Strutt.—Some Electrical and Chemical Effects of the Explosion of Azoimide: Rev. P. J. Kirkby and J. E. Marsh.—Factors Affecting the Measurement of Absorption Bands: H. Hartridge.—The Refraction and Dispersion of the Halogens, Halogen Acids, Ozone, Steam Oxides of Nitrogen and Ammonia; and the Causes of the Failure of the Additive Law: Clive Cuthbertson and Maude Cuthbertson.—Liquid Measurement by Drops: R. Donald.—The New Theory of Integration: Prof. W. H. Young.—Negative After-images with Pure Spectral Colours: Dr G. J. Burch.—A New Method of Measuring the Torque produced by a Beam of Light in Oblique Refraction through a Glass Plate: Dr. G. Barlow.—The Positive Ionisation produced by Platinum and by certain Salts when Heated: Dr. F. Horton.

ROYAL INSTITUTION, at 3.—Birds of the Hill Country: Seton Gordon.

LINNEAN SOCIETY, at 8.—A Visit to Madagascar in Search of Subfossil Lemuroids: The Hon. P. Methuen.—Les Caridines des Seychelles, avec des Observations sur leurs Variations: Prof. E. L. Bouvier.—Psychodidæ of the Seychelles; Ephemeridæ of the Seychelles: The Rev. A. E. Eaton.—Odonata of the Seychelles: H. Campion.—A New Land Leech from the Seychelles: W. A. Harding.—Some New British Plants: G. C. Druce.

ROYAL SOCIETY OF ARTS, at 4.30.—Agricultural Progress in Western India: G. F. Keatinge.

INSTITUTION OF MINING AND METALLURGY, at 8.—(1) Some Considerations on the Specification of Theodolites for Mines; (2) Specification of a Precision-Theodolite (for Workings on Lodes of Medium Inclination and Narrow or Medium Thickness): L. H. Cooke.—Description of a Modern Lead Concentrating Mill, Broken Mill Junction North Mine, N.S.W.: S. C. Bullock.—The Blast Roasting of Sulphide Ores: J. H. Levings.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—Further Applications of the Method of Positive Rays: Sir J. J. Thomson.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Indicators: J. G. Stewart.

MONDAY, JANUARY 20.

ROYAL SOCIETY OF ARTS, at 8.—Liquid Fuel: Prof. Vivian B. Lewes.

VICTORIA INSTITUTE, at 4.30.—The Fact of Prediction: Rev. J. Urquhart.

TUESDAY, JANUARY 21.

ROYAL INSTITUTION, at 3.—The Heredity of Sex and Some Cognate Problems: Prof. W. Bateson.

ROYAL STATISTICAL SOCIETY, at 5.—The Population of England in the Eighteenth Century: Prof. E. C. K. Gonner.

MINERALOGICAL SOCIETY, at 5.30.—Optical Activity and Enantiomorphism of Molecular and Crystal Structure: T. V. Barker and J. E. Marsh.—Note on the Determination of the Optic Axial Angle of Crystals in Thin-section: H. Collingridge.—Graphical Determinations of Angles and Indices in Zones: Dr. G. F. Herbert Smith.—The Goldschmidt Apparatus for Cutting Models of Crystals: J. Drugman.—A Nodule of Iron Pyrites: Prof. H. L. Bowman.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The London and South-Western and Metropolitan District Railways' Widening between Acton Lane and Galena Road: E. A. Ogilvie.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.

WEDNESDAY, JANUARY 22.

GEOLOGICAL SOCIETY, at 8.—The Fossil Flora of the Marske Quarry (Yorkshire): H. Hamshaw Thomas. With Notes on the Stratigraphy: Rev. G. J. Lane.—The Derived Cephalopoda of the Holderness Drift: C. Thompson.

ROYAL SOCIETY OF ARTS, at 8.—Advertising: E. Street and L. Jackson.

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Relation of the Islets of Langerhans to the Pancreatic Acini under Various Conditions of Secretory Activity: Dr. J. Homans.—The Metabolism of Lactating Women: E. Mellanby.—(1) Colour Adaptation; (2) Trichromic Vision and Anomalous Trichromatism: Dr. F. W. Edridge-Green.—Transmission of Environmental Effects from Parent to Offspring in Simocephalus: W. E. Agar.—Contributions to the Histo-chemistry of Nerve; the Nature of Wallerian Degeneration: H. O. Feiss and W. Cramer.—Onychaster, a Carboniferous Brittle-star: I. B. J. Sollas.

ROYAL INSTITUTION, at 3.—Birds of the Hill Country: Seton Gordon.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Use of a Large Lighting Battery in connection with Central Station Supply: F. H. Whysall.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—Recent Advances in Scientific Steel Metallurgy: Prof. J. O. Arnold.

PHYSICAL SOCIETY, at 5.

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No. 2256, Vol. 90] THURSDAY, JANUARY 23, 1913 [Price Sixpence

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THURSDAY, JANUARY 23, 1913.

A PIONEER IN APPLIED SCIENCE.

Collected Papers in Physics and Engineering. By Prof. James Thomson, F.R.S. Selected and arranged with unpublished material and brief annotations by Sir Joseph Larmor, Sec. R.S., and James Thomson. Pp. civ + 484. (Cambridge: University Press, 1912.) Price 15s. net.)

WHEN Sir Joseph Larmor edited the scientific papers of Lord Kelvin and Prof. Fitzgerald he did work which nobody else could have done so perfectly; his time, however valuable, was spent to advantage. The editing of these papers of Lord Kelvin's brother might have been undertaken by many others, but now that the excellent result is before us we cannot regret it, and we must confess that we did not expect to find in the editor such a perfect sympathy with James Thomson's methods of study. He shares with Prof. Thomson's son the honour and credit of this publication. The book begins with about a hundred pages of biography and comment upon Thomson's works—excellent reading. Then we have 153 pages of papers relating to fluid motion, dating from 1852 to the Bakerian lecture of 1892; nearly eighty pages on congelation and liquefaction from 1849 to 1888; forty pages on the continuity of states in matter from 1869 to 1873; seventy pages on dynamics and elasticity from 1848 to 1887; and about eighty pages on geological and miscellaneous subjects from 1848 to 1892.

James Thomson was very exact in his use of language and in his ways of thinking. Even although in some of our studies we are quite exact, most of us are quite slipshod about other things that we think we know. If it were necessary to give examples the reader might be referred to paper 14 of this collection. Thomson there refers to the usual methods of study of the flow of water. He says: "The theoretical views so arrived at and very generally promulgated are in reality only utterly false theories based on suppositions of the flow of the water taking place in ways which are kinematically and dynamically impossible, and are at variance with observed facts of the flow, and even at variance with the facts as put forward by the advancers of those theories." After giving some examples, he says: "Now this method is pervaded by false conceptions and is thoroughly unscientific." Although Thomson constructed his famous turbine sixty years ago and put in simple language the principles on which nearly all modern water and steam turbines are now being constructed, these papers of his are so little known that nearly all books on hydraulics are still pervaded with the old false conceptions and unscientific methods.

He was free from the common fault of self-deception. There is no vagueness in any of his explanations of phenomena. When he explains such a thing as the tears of strong wine and refers to surface tension he is as exact as Prof. Boys or Lord Rayleigh, and he demands from his reader the same carefulness. When he is not perfectly sure of a thing he tells you so frankly. The results of Thomson's thought in so far as physics is concerned are known to all of us; they are to be found in all text-books; I wish we could say the same about his work in engineering. But both physicist and engineer will get much education in reading the original papers. They will come in contact with a true scientific mind, absolutely honest, intensely observant, afraid of self-deception, concentrative, persistent and tireless. I have no hesitation in saying that the hydraulic engineer who has not read these papers has a great deal to unlearn and learn.

Only the very simplest mathematical or scientific knowledge is needed by the reader, but he must have common sense and humour and the same inclination to laugh at pretentious, ignorant notions as the author himself. I think myself that in a few cases Thomson ought to have worked with higher mathematics. For example: water being supposed to be frictionless and to flow from two similar vessels with similar and similarly placed orifices, he thought it necessary to prove that the lines of flow are similar. If this is so, it is evident that if l and L are the dimensions, p and P the pressures, v and V the velocities at similar places, then $P/p = L/l$ and $V/v = \sqrt{L/l}$. His proof of the similarity is ingenious. Applied to the case of vessels moving through water it is Froude's law, but in this case, unlike Thomson's own, viscosity enters into the real phenomena in an all-important way, and the assumption that the proposition has been proved is very dangerous. Thomson used his proposition in getting a rational formula for the measurement of water by his triangular notch, and in proving that the empirical formula of Dr. Francis for rectangular notches is really a rational formula. It is curious that it should be necessary to tell engineers that the Francis formula is correct and that the usual formulæ of the text-books are quite incorrect.

Now that long proof given by Thomson in his 1876 paper (given by him to students in his classes for fifteen years previously) seems to me unnecessary. In one of his vessels A the flow is natural, and in the other B he guides the flow in stream lines similar to those of A; he shows that there are no forces tending to deform the guides of B, and if we imagine them to disappear the flow is unchanged and remains similar to the flow in A. But since he proves so much, he ought to prove that there is no other way in which the flow can occur in B, and I am afraid that this cannot be done except by Kirchoff's use of higher mathematics. Indeed, Kelvin showed that there might be two answers to all such problems, one of them being unstable.

The first of these fluid motion papers (1852) deals with the free vortex. The example to which he most frequently referred his students was that of water leaving a basin by a central hole. The nearly circular motion of every particle is such that the speed is inversely proportional to distance from the axis, and he satisfied himself that our simple theory as to pressure, circular speed v, and height was correct. But he noticed that particles of dust on the lower surface of the basin moved in towards the hole nearly radially; he arrived at the conclusion that surface friction destroyed v, and therefore destroyed the centrifugal force, and therefore destroyed the balance of pressures, and therefore created a radial flow. This simple principle gave the key to the atmospheric phenomena of great forest fires; it enabled him to explain what occurs at river bends and why a river through alluvial ground tends to become more and more crooked; it enabled him to explain the phenomena of cyclones, and, most important of all, it enabled him in 1857 to give his simple explanation of what had puzzled many clever scientific men for two hundred years, the grand currents of atmospheric circulation. That short paper is easy to understand. The Bakerian lecture of the Royal Society with the same title, delivered in 1892 two months before his death, added nothing to that simple explanation, then thirty-five years old, but in it he gave at some length the history of the problem.

Hadley, in 1735, explained the trade winds in latitudes 30 S. to 30 N., but in all the numerous writings by distinguished men before and after Hadley until 1857 there was only slipshod reasoning and no explanation of the prevailing S.W. winds north of latitude 30 N. There is a whirl of the atmosphere there from the west which would produce no northerly flow of the air, only that there is friction against the earth; this diminishes the speed of the air and upsets the balance of pressures, producing a northerly flow close to the earth's surface—exactly the basin phenomenon! His proof, in 1849, that pressure lowers the melting point of ice consists in subjecting a mixture of ice and water to a Carnot cycle. He assumes with Carnot that no heat disappears when work is done, but he states quite clearly, as nobody else had ever done, what the third part of the cycle would be if Carnot were wrong and if less heat were given out than what had been received.

Using Regnault's experimental results for steam, Lord Kelvin had in 1848 calculated the value of Carnot's function, and James Thomson used the result, which was this:—"We find that the quantity of work developed by one of the same thermal units descending through one degree about the freezing-point is 4·97 foot-pounds." This enables him to find that the lowering of the melting-point is 0·00000355 p where p is the increase of pressure in pounds per square foot. This paper and Kelvin's paper and their connection with the vexed question, "Who discovered the second law?" are exceedingly interesting. Kelvin's paper of 1851 first established the second law on a logical basis irrespective of assumed properties of matter, and Kelvin was too generous in giving credit to Clausius and, indeed, to Rankine also. But these four men and Joule himself were all very close to the discovery in the three years 1848 to 1851. I know of no more interesting reading than what I find in Prof. Silvanus Thompson's life of Lord Kelvin during these years. No one of Plutarch's heroes "played the game" more nobly than the Thomsons.

James Thomson reasoned out from the above principle the cause of the flow of glaciers and the plasticity of ice and other curious ice phenomena, as well as the influence of stress on crystallisation generally, in a series of papers and letters until 1889. In 1862 he had made a model of a surface showing how p, v and t for carbonic acid vary, and had thought of conditions of instability. Dr. Andrews's Bakerian lecture of the Royal Society in 1869 caused him to revert to his previous study of the discontinuities of his surface, to complete his model and to write papers of 1871 on the abrupt changes at boiling and condensing. He reasoned out the existence of the triple point for ice, water and steam in 1872 and 1873 in the same way as that of his 1849 paper on ice. The one p, t curve for saturated steam drawn on copper by Regnault is really two curves the slopes of which at 0° C. are not the same, being in the ratio dp/dt for ice-steam $\div dp/dt$ for water-steam $= 1·13$. These matters are familiar to all readers of Maxwell's book on heat, but the student will be interested in the letters and notes from 1862 which describe how Thomson was led to his results. He used to tell his students, with some glee, how his eye detected in Regnault's curve the discontinuity at 0° C. which nobody had noticed before.

His valuable papers on the strength and elasticity of materials, the theory of springs, safety and dangers in structures and the testing of structures, on units, on dimensional equations, on absolute motion, on fatigue of materials are less well known, but students who read them will get a clear insight into subjects on which text-book reasoning is sometimes rather slipshod. His paper on the parallel roads of Lochaber is acknowledged to have cleared up a great geological puzzle. His paper on prismatic structure in basaltic rocks cleared up the Giant's Causeway puzzle.

In his paper of 1872 on atmospheric refraction of inclined rays and on the path of a level ray he solved another important problem. His integrating machine is now in use for tide-calculation. There are many papers on subjects of general interest to which I cannot refer because I have no space. Suffice it to say that on every subject about which he wrote he threw a new light, he gave fresh ideas, and he started students on new lines of thought. In reading one of his papers we instinctively feel sure that he has given long and careful consideration to the matter and has looked at it from many points of view; consequently he has exact and clear ideas, and he is able to state them in simple language, so that we at once accept his conclusions as correct.

JOHN PERRY.

TABLES OF THE WEIGHT OF AIR.

Tabellen der Luftgewichte γ_t^h, *der Druckäquivalente* β_t^h *und der Gravitation* g.
Tables des poids de l'air γ_t^h, *des équivalents barométriques* β_t^h *et de la gravité* g.
Tables of the Weight of Air γ_t^h, *of the Air-Pressure Equivalents* β_t^h *and of the Gravity* g. By Dr. S. Riefler. Pp. iv + 101. (Berlin: Julius Springer, 1912.) Price 6 marks.

IN rough experiments, the density or the weight of the air may often be ignored; generally, however, it is allowed for with more or less completeness. But when it is desired, as in the author's work, to make a precise determination, so precise that the effect of moisture in reducing it, or carbonic acid gas in increasing it, must not be ignored, and when the local value of g has to be allowed for, then the investigator may find the calculation to be unduly tedious.

The author of these admirable tables has been brought face to face with the difficulty in connection with the disturbing effect of the density of the surrounding air on the period of the pendulum of the astronomical clock. For instance, the rate of such a pendulum is changed by 1/100 second per day, so he states, by a variation in weight of one milligram per litre in the air surrounding the pendulum. He has, therefore, calculated a series of tables, where they were not already in existence, whereby all the data required can be found with the maximum of directness and accuracy and the minimum of trouble. Every table has the formula on which it is based printed at the head, and a clear statement of the whole problem is printed in three parallel columns in German, French and English. In only one case is this departed from, where the names of the countries in which a large number of stations are situated for which g has been determined are printed in English only, "on account of the extended use of this language"—a compliment which an English paper should acknowledge.

The most important of the tables is calculated for every 10 mm. of barometric height from 380 to 680 mm., and then for every mm. up to 790 mm., and for every degree of temperature from $-1°$ C. to $+36°$ C. For all these conditions the weight of a litre of air free from CO_2, but both dry and half saturated with moisture, is calculated on the basis that at Paris the weight of dry air free from moisture and CO_2 is, under standard conditions, 1293·21 mg. Alongside the figure giving the weight is another, called by the author "the pressure equivalent of temperature," which shows the change in pressure in mm. of mercury due to a change of 1° C. in temperature. It is interesting to notice that this, in the case of half-saturated air at 760 mm., has a minimum value at about 17° C.

It would require more space than is available to discuss the tables fully. It is sufficient to say that the printing, the paper and the arrangement are all admirable, and that these tables should be found in every laboratory where exact work is done.

C. V. B.

ANTHROPOLOGY AND ARCHÆOLOGY.

(1) *The Annual of the British School at Athens.* No. xvii. Session 1910–11. Pp. liv + 355 + xxi plates. (London: Macmillan and Co., Ltd., 1912.) Price 25*s*. net.
(2) *The Cochin Tribes and Castes.* By L. K. Anantha K. Iyer. Vol. ii. Pp. xxiii + 504. (Madras: Higginbotham and Co.; London: Luzac and Co., 1912.)
(3) *The Origin of Civilisation and the Primitive Condition of Man.* Mental and Social Condition of Savages. By the Right Hon. Lord Avebury. 7th edition. Pp. xxviii + 454. (London: Longmans, Green and Co., 1912.) Price 7*s*. 6*d*. net.
(4) *Notes and Queries on Anthropology.* Edited

for the British Association for the Advancement of Science by Barbara Freire-Marreco and Prof. J. L. Myres. 4th edition. Pp. xii+288. (London: Royal Anthropological Institute, 1912.) Price 5*s*.

(5) *Rough Stone Monuments and their Builders.* By T. E. Peet. Pp. xii+172. (London and New York: Harper and Bros., 1912.) Price 2*s*. 6*d*. net.

(1) THE last issue of the Annual of the British School at Athens opens with an interesting review of the working of this institution since its foundation in 1883, prepared by the honorary secretary, Mr. G. A. Macmillan. In spite of its limited resources, the school, which deserves more active support from archæologists and students of classical literature in this country, has done most valuable work in the excavation of historical sites, and in the preparation of monographs on the archæology and anthropology of Greece and the eastern Ægean area. In the present volume, besides reports on the topography of the Troad, Thebes, Phylakopi, Phokis, and other places, Mr. W. R. Halliday has made an important contribution to the study of comparative religion in his article entitled "Cenotaphs and Sacred Localities," in which he deals with the stratification of local beliefs. It is interesting to read a description of a Thracian Tholos tomb at Kirk Kilisse, written before the recent campaign which has directed public attention to this place. The number, as usual, is provided with a fine series of maps and illustrations.

(2) Mr. L. K. Anantha Krishna Iyer, in the new volume of his survey of the people of the Cochin State in south-western India, passes from a description of the degraded forest and menial tribes to the higher castes, with whom he is much more personally familiar. He begins with an elaborate account of the Brahman classes, which display remarkable differences in beliefs and customs as compared with their brethren in northern India, from whom they form a comparatively recent offshoot. Then come the Nayars, with their strange marriage regulations and their unique association with the Nambutiri Brahmans. Equally interesting are the Mohammedan Mappillas, a race subject to occasional outbreaks of savage fanaticism which has from time to time nerved them to resist British troops. We have a full account of the remarkable colony of White and Black Jews, whose origin and history are still subjects of controversy. Finally, he describes the Syrian Church of Malabar, an institution of much interest to students of the history of Christianity. On all these varied races the author has collected a mass of valuable information. This book, for which anthropologists are indebted to the liberality of the State Government, is excellently produced, and supplied with admirable photographic illustrations. Thanks to the writer and Mr. Edgar Thurston, the ethnologist is now provided with a trustworthy account of the races of southern India. The survey will be completed by a third volume devoted to physical anthropology, the appearance of which will be awaited with much interest.

(3) Lord Avebury's work on primitive civilisation, first issued in 1870, now ranks as an anthropological classic. It is, however, much to be regretted that the author, in this new edition, has been unable to subject the work to a thorough revision and bring his authorities up to date. It is true that in his introduction he refers to some recent work, and discusses with admirable restraint the vivacious criticisms of the late Mr. Andrew Lang on the views expressed on savage religion; but, frankly speaking, his bibliography and references are not up to the level of modern research. A list of authorities on the beliefs and sociology of primitive man which ignores Sir E. Tylor's "Primitive Culture," and writers like Profs. Frazer and Westermarck, Messrs. Crawley, Hartland, and Lang, is clearly inadequate, and the authorities quoted in the notes, though good of their kind, are prehistoric, because they do not include recent surveys of savage life in Australia, India, America, Africa, or Melanesia. It may be hoped that in the next edition of this useful book Lord Avebury will take the opportunity of subjecting it to thorough revision, by bringing the bibliography up to date, and improving the notes by quotations from the works of modern travellers and ethnologists.

(4) The "Notes and Queries on Anthropology," issued by the Royal Anthropological Institute with the aid of a grant from the British Association, now appears in a thoroughly revised edition, prepared under the superintendence of Miss Freire-Marreco and Prof. J. L. Myres. Every chapter of the work bears the marks of careful and judicious reconsideration, and, as it stands, it should be in the hands of every traveller and official who has the chance of investigating savage races. In future editions of this valuable *questionnaire*, it might be advisable to extend the list of works recommended to the student, which only very imperfectly represents the best modern work. A section might also be added suggesting the precautions under which these elaborate interrogatories should be used in field work, with a suggestion, gathered from the experience of those familiar with savage races, of the best methods by which trustworthy information can be collected.

(5) The question of the origin of megalithic monuments and of the race by whom they were constructed has acquired fresh importance from the discussion, at the recent meeting of the British Association at Dundee, of the theories advanced by Prof. G. Elliot Smith, who attributes them to influence from Egypt, where he assumes that the invention of copper led to the use of carved stone. Mr. Peet's method in the present book is to give a summary account of megalithic monuments throughout the world, to which he adds some cautious, well-considered speculations on their origin and diffusion. He fully recognises the difficulty, in the present state of our knowledge, of deciding the centre from which they were derived. He suggests that the idea of the rock-tomb was brought into the megalithic area by the builders of the monuments, that it did not result from contact with the eastern Mediterranean, and that there is no direct connection between the corridor tombs of the megalithic countries and the great Tholoi of Crete and the Greek mainland. The book may be safely recommended as a cautious summary of a most difficult problem.

RECENT BOOKS ON PHYSICAL SUBJECTS.

(1) *Elements and Electrons.* By Sir W. Ramsay, K.C.B., F.R.S. Pp. ix + 173. (London and New York: Harper and Brothers, 1912.) Price 2*s*. 6*d*. net. (Harper's Library of Living Thought.)

(2) *Radium and Radioactivity.* By A. T. Cameron. Pp. 185. (London: S.P.C.K., 1912.) Price 2*s*. 6*d*. (Romance of Science Series.)

(3) *A Handbook of Physics.* By W. H. White. Pp. xv + 667. (London: Methuen and Co., Ltd., n.d.) Price 7*s*. 6*d*.

(4) *A Course of Physics, Practical and Theoretical.* By Dr. C. H. Draper. Pp. xi + 413. (London: Blackie and Son, Ltd., 1912.) Price 4*s*. 6*d*. net.

(5) *La Théorie des Ions et l'Électrolyse.* Deuxième Édition. By A. Hollard. Pp. vii + 220. (Paris: Gauthier-Villars, 1912.) Price 5 francs.

(6) *Lehrbuch der Optik.* Dritte erweiterte Auflage. By Dr. Paul Drude. Herausgegeben von Dr. E. Gehrcke. Pp. xvi + 548. (Leipzig: S. Hirzel, 1912.) Price 12 marks.

(7) *Electricity and Its Practical Applications.* By Prof. M. Maclean. Pp. xiv + 492. (London: Blackie and Son, Ltd., n.d.) Price 10*s*. 6*d*. net.

(1) IT need scarcely be stated that a popular treatise from the pen of Sir William Ramsay is sure to be of absorbing interest. This is particularly the case with the present volume, with the subject of which the author's name is so intimately associated. The various stages in the development of chemistry, and later of radioactivity, are sketched in a manner quite delightful, and although the treatment of the mechanics involved may be regarded by some as rather loose, it is only in a few instances that this objection can be raised, and it should be remembered that, after all, the readers will not all be strict mathematicians.

The principal chapters are those which deal with Dalton's atomic theory, molecular weights, the periodic table, molecules—invisible and visible—electrons, radioactivity and transmutation. Probably the last of these is that which will invoke the greatest interest. It is common knowledge that Sir William Ramsay's work in this field has been received in some quarters with scepticism, and, of course, all controversies are popular. The author draws a distinction between "transmutation" and "transformation," the former applying to controlled changes as distinct from natural changes. Among the reasons brought forward as indicating the probable effect of corpuscular bombardment in producing transmutation, it is suggested that it may be due to high temperature. The "temperature" of rapidly moving alpha particles is calculated upon the kinetic theory, and the number obtained is enormous.

With this view it is difficult to agree, for even if we admit the validity of this calculation as representing the temperature of the particles themselves, it cannot be claimed that it also measures the temperature of the body bombarded. But apart from this, the accumulated evidence of transmutation which is recorded in this chapter should not be lightly dismissed, especially coming as it does from the discoverer of the spontaneous production of helium from radium. It may be scarcely credible, because so extraordinary, but it may, nevertheless, be true.

(2) This is another little book on somewhat similar lines, although, in this case, radioactivity is the sole subject. The author takes the very reasonable view that some knowledge of physics and chemistry must be assumed in the reader, but the calls on this knowledge are neither great nor numerous, and will form no bar to the majority of students. A straightforward and interesting account of the main radioactive phenomena constitutes the contents of the book, and the novice who desires some acquaintance with this wonderful new subject could not do better than acquire a copy.

(3) It is not often that one comes across a text-book exhibiting so much originality as that which Mr. White has recently produced. To say that

it differs from the ordinary text-book scarcely expresses the truth of the matter. It is so often found that a new book on physics merely consists of previous works *plus* a few modifications and additions. Here, however, internal evidence makes it perfectly clear from page to page that the author is indeed the author.

The book is a very good one indeed, and should find a large sale among those students of physics who need in a single volume a treatment of the subject rather more than elementary. It is true that in many places the illustrations of physical principles used verge on the ludicrous, and that the mode of expression often seems out of place, but the redeeming feature is that the illustrations are excellent. It may be said, in fact, that by reason of the frequent recourse to everyday occurrences as constituting examples of various physical phenomena this book is chiefly noteworthy. A few of them, notably those connected with physiological processes, may, perhaps, be beyond the average student, but the author has evidently introduced them for the special benefit of students of medicine. One undesirable feature may be mentioned in conclusion, namely, the fact that the author has attempted in several places to conduct algebraic calculations in words instead of symbols, the result being that the reasoning, although correct, is very difficult to grasp.

(4) This is a combined theoretical and practical text-book intended for schools, and to be covered normally on a three-years' course. In most respects it resembles the usual school-book. It is, however, a good plan to describe in one volume the methods of doing experiments and the theoretical treatment of the principles involved.

(5) The author of this book has produced a useful record of much of the experimental work which has been done on electrolysis, and interprets the results upon the theory of ionisation. He claims that the simple theory, although admittedly inapplicable to concentrated solutions, yet may afford a basis to which modifications may be made, just as did Mariotte's and Gay-Lussac's laws for gases. The subject is divided into four sections, namely, the constitution of electrolytes, their conductivity, contact potential, and electrical energy. A considerable number of tables are given recording numerical values of such quantities as heats of ionisation and conductivities of acid solutions of various strengths.

(6) In a book having the reputation of the late Prof. Drude's "Optics," the chief interest in the appearance of the third edition is attached to the modifications and additions introduced. Such a book would be hard to improve, and might easily be spoilt. Prof. Gehrcke has wisely refrained from making any serious alterations, and the additions are few in number, the principal being a short description of Stokes's theory of aberration and a paragraph or so on the photochemical effect on gases. The treatise is still Drude's "Optics," and will continue to merit the high place it already holds in physical science.

(7) This volume has been written for the use of students of electrical engineering. It consists of the treatment of magnetism and electricity, first of all from the theoretical point of view, and then in connection with its various applications. The mathematical treatment is quite elementary—it is, in fact, based on Deschanel's "Natural Philosophy," so far as the purely theoretical part is concerned, many of the diagrams also being reproduced from that treatise. A series of tables of constants and various questions and exercises add to the value of the book, which appears to be well fitted for its purpose.

OUR BOOKSHELF.

La Cementazione dell' Acciaio. By Dr. Frederico Giolitti. Pp. xi + 506. (Torino: Unione Tipografico-Editrice Torinese, 1912.)

IN the present work, Prof. Giolitti has collected together the important experimental results obtained by his fellow-workers during the last four years relative to the cementation of steel. At the same time, he has presented an exhaustive review of the subject from its scientific and technical aspects. The chemical nature of the process of cementation (in which term case-hardening is included) has been the subject of many controversies, and it cannot be said that the mechanism of the transport of carbon is even now understood. Prof. Giolitti subjects the extensive literature of the question to a critical review, which does not appear to omit any work of importance, English and German memoirs being examined as thoroughly as those in Italian and French. This part of the book might, perhaps, have been somewhat condensed by the omission of repetitions, but it forms an excellent source of reference for a class of facts of great importance for the general theory of metallic alloys. The chapter in which the results of previous investigations are summed up scarcely gives sufficient attention to the fact, now fully established, that carbon diffuses in the solid as a carbide, and not in the free state.

The author's own researches, which occupy the larger part of the book, deal mainly with the specific influences of carburising gases (hydrocarbons and carbon monoxide, alone or in the presence of solid carbon) in the process of cementation. Details are given of the experimental conditions employed, and of the technical processes based on the experiments. The methods are of great scientific as well as technical interest as examples of the application of a purely physicochemical study of equilibrium to an industrial operation. The work is an important and valuable contribution to the literature of metallurgy.

C. H. D.

Index Zoologicus No. II. Compiled (for the Zoological Society of London) by C. O. Waterhouse and edited by David Sharp, F.R.S. Pp. vi+324. (London: Printed for the Society, 1912.) Price 15*s*.

THE subtitle of this volume describes its scope; it runs: "An alphabetical list of names of genera and subgenera proposed for use in zoology as recorded in the 'Zoological Record,' vols. 38–47 inclusive (1901–1910), and the zoology volumes of the 'International Catalogue of Scientific Literature,' annual issues 1–10, together with other names not included in previous nomenclators." The first volume was published in 1902, and the primary object of the present work is to serve as an index to the intervening ten years, but it is also planned so as to be with Scudder's "Nomenclator" a complete register of the names of genera and subgenera proposed for use in zoology. The editor of this volume points out that 140,000 names have been, up to the present time, proposed for the genera and subgenera of zoological taxonomy.

Systèmes Cinématiques. By Prof. L. Crelier. Pp. 100. (Paris: Gauthier-Villars, 1911.) 2 francs. (*Scientia.* Janvier, 1911. Phys.-Mathématique. No. 31.)

UNDER the above title, the author investigates the motion of a right-angle one side of which passes through a fixed point, while the vertex describes a fixed right line or circle, that of a rod sliding between axes at right-angles, that of a crank connecting rod, and so forth; altogether, six methods of generation are investigated. The curves associated with these moving systems include the base and rolling centrodes or loci of the instantaneous centres, the envelope of the moving line and those of other lines associated with it, the trajectories of various points of the figure, and certain envelopes of their tangents. In this way a large number of curves are obtained, possessing interesting properties; of course, many of these are already well known. The figures in the book are rather complicated. The book contains a portrait of Col. Mannheim and a short bibliography.

Internal Secretion and the Ductless Glands. By Prof. Swale Vincent. With a preface by Prof. E. A. Schäfer, F.R.S. Pp. xx+464. (London: Edward Arnold, 1912.) Price 12*s*. 6*d*. net.

PROF. SWALE VINCENT is well known as an investigator who has devoted much attention to one of the most interesting chapters of physiology, namely, that which deals with the group of organs, formerly so mysterious, which are known as the ductless glands. The adrenal bodies, the thyroid and parathyroids, the thymus, the pituitary, pineal, carotid, and coccygeal bodies are the principal ones treated, but, as is well known, internal secretions are also formed by glands which possess ducts, and so we also have chapters on the pancreas, liver, kidney, and reproductive organs. The literature of the subject is enormous, and in presenting a lucid and terse account of the recent progress of science, and in ferreting out the 3000 or more references which deal with it, the author has, as Prof. Schäfer says in his preface, laid us under a deep debt of gratitude. W. D. H.

A Laboratory Manual of Agriculture for Secondary Schools. By Prof. L. E. Call and E. G. Schafer. Pp. xv+344. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1912.) Price 4*s*. net.

THIS book is issued to supply the demand that has arisen for laboratory exercises in the teaching of agriculture in the United States. Directly agriculture becomes a school subject (and it is for secondary schools that the book is intended), it becomes necessary that the teacher should be provided with a number of simple experiments within the capacity of the scholars and of the school equipment. Of course, the out-door observations must still remain the essential groundwork of the instruction, but a well-chosen course of laboratory experiments can be arranged to bring out the main principles and illustrate the working of the individual factors involved.

The lessons deal with soils, crops and animals. For convenience of working they are arranged in calendar form, beginning in September and continuing through to May, with an "extra" for Arbor Day. They have actually been carried out in schools, so that they are known to be workable.

The soil experiments deal mainly with the moisture relationships, which in Kansas play a large and sometimes a controlling part in soil fertility. The crops studied include the cereals, cowpeas, cloves, lucerne and potatoes: the exercises range over the germination of the seed, the development of the root and seed, and the examination of the harvest. The animal section is based on the score-card method, devised in America and found so useful that it has been introduced into this country.

Teachers of agriculture will find many useful and suggestive lessons in the book, and it will serve as an excellent example of the standard of instruction aimed at in the American schools.

LETTERS TO THE EDITOR.

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An Effect due to the Sudden Great Increase of Pressure.

IN the course of some experiments on the mapping of the lines of electric force between two charged conductors, a remarkable effect, due to the sudden very great rise in pressure in the oil separating them, occurred. The conditions of the experiment necessitated the use of two pointed strips of tinfoil, separated by an interval of 1/16 in., laid on a sheet of glass with a drop of turpentine, to act as an insulator, between them. On this was laid a thin cover-glass, as used for covering objects when mounted for the microscope. Unintentionally the potential between the two tinfoil strips rose high enough to permit a spark to pass through the oil between them, and when this occurred a small piece was blown out of the centre of the cover-glass, being about 1/16 in. in diameter on the upper side and about half this on the lower, the piece of glass having the appearance of a small truncated cone. The cover-glass was only held down by the film of oil separating it from the strips of tinfoil; yet the fragment of glass was ejected with considerable force.

The cause of the effect may be explained as follows: the energy liberated from the spark was sufficient to cause the pressure to rise rapidly to a high value in the confined space, either by decomposing the oil and heating the liberated gas, or by forcing away the oil along its path, and so compressing it. (We are, however, not concerned here with the question as to whether the pressure on the glass cover had its seat in the oil alone or in the gas liberated from the oil, but only with the fact that the passage of the spark through the oil gave rise to a series of events which culminated in the forcing out of a plug of glass from the cover.) As the time during which the spark lasted was almost negligible, the rate at which the pressure rose near the spark was great enough to send out a pulse of pressure through the oil. This pulse striking the thin cover-glass had sufficient energy stored in it to cause the small piece of glass to be removed from it.

This effect is the converse of that noted by Mr. J. Y. Buchanan during the voyage of the *Challenger* in 1873, and repeated by him while on board the yacht of H.S.H. the Prince of Monaco, the *Princesse Alice*, in the summer of 1902 (see Proc. Roy. Soc., 1903, vol. lxxii., p. 88; or NATURE, 1903, vol. lxviii., p. 334). I will quote from Mr. Buchanan's paper:—"The brass tube (Figs. 1 and 2, plate i.) above referred to was the case for holding a piezometer which was accidentally broken. With it I repeated the experiment which I had made in the *Challenger*, with this difference, that I used only one sealed glass tube. It was an ordinary pipette of 50 c.c., sealed up at both ends close to the body. It was wrapped in a piece of muslin and loosely packed with cotton waste so as to occupy the middle of the brass tube.

"The length of the brass tube was 33 cm., and its diameter 4·13 cm. Its weight without the cover was 350 grams. Both the top and the bottom are pierced with many holes so as to allow passage to the water.

"Thus charged, it descended on the sounding line to a depth of 3000 metres, and when it came up it was evident from its appearance that the experiment had succeeded. As in the experiment on board the *Challenger*, the glass had been converted into a snow-white powder. The external effect also was confined entirely to that part of the brass tube which had been occupied by the sealed glass tube. Above and below it there was no disfiguration."

In this case it was easier for the water outside to distort the brass tube than to flow through the perforated caps covering the ends, and so fill the space lately occupied by the glass bulb. In the case of the punctured cover-glass the pressure rose so suddenly on the spark passing through the oil that there was not sufficient time to raise the glass as a whole, or to push away the film of oil lying between it and the glass slide, with the result that a minute piece of glass was forcibly blown out. Had the cover-glass possessed the ductility of brass, there would perhaps have been a bulge formed instead of a piece being bodily removed.

On another occasion I had a practical demonstration of the power given out by a spark. It was in the early days of wireless telegraphy, and I had constructed an oscillator of a simple type, consisting of a pair of brass balls immersed in paraffin oil, the oil and balls being contained in an inverted bottle from which the bottom had been removed. The bottle was about 2½ in. in diameter, and about 4 in. deep, and the balls were situated at the centre, one above the other, and ⅛ in. apart. I had not passed more than about a dozen sparks between the balls when suddenly the glass was shattered. The large end of the bottle was open, and the free surface of the oil was about 2½ in. in diameter. We have in this case direct evidence of a pressure being transmitted in the form of a pulse, or single wave, to the glass containing vessel of an intensity sufficient to cause it to break. The cause of this pressure was the spark passing from ball to ball through the oil, and while passing pushing away the oil on all sides with a rapidity which gave rise to a pulse of pressure. This pulse travelled outwards with great velocity, and contained such a store of energy that on striking the sides of the vessel it was sufficient to rupture the glass. The potential energy of the original electric charge was converted into the kinetic energy of the spark, and this in turn was transformed into the energy of the pulse, which was finally transferred to the glass. As the amount of energy was too great for the glass to hold, it found an outlet in shattering the vessel.

The "pressure in an electric spark" is a term by no means uncommon in scientific literature, yet but little attention is paid to the effects which this pressure exerts on surrounding objects, as, for example, when a tree or house is struck by lightning. They all belong to the type mentioned above.

In conclusion, I would recommend a careful study of the paper by Mr. J. Y. Buchanan referred to above to those interested in the subject of the sudden *relief* of great pressure. W. G. ROYAL-DAWSON.

17 Pembridge Gardens, London, W.
January 8.

The Halo in the Ricefield and the Spectre of the Brocken.

IN connection with the curious Japanese phenomenon of the halo seen around the head of the shadow of a person standing in a ricefield in early morning (NATURE, p. 419, December 12, 1912), it may be of interest to recall that some recent balloon voyagers have reported observations of a bright halo surrounding the shadow of the car thrown upon a horizontal cloudfield by oblique solar rays. Coloured diffraction rings are sometimes seen surrounding the head of the "spectre of the Brocken," but for these to be visible theory requires that the drops constituting the mist should be of uniform size. In an article in the *Meteorologische Zeitschrift* (p. 282, June, 1912; see also *Science Abstracts*, p. 574, December, 1912), by Prof. F. Richarz, discussing the theory of the subject, reference is made to an observation by Dr. Bieber from the balloon *Marburg* of a halo around the shadow, and also to other verbal communications of a similar character. Prof. Richarz's article is followed by another describing a photograph taken by Dr. Wegener of a series of three diffraction rings seen around the shadow of the same balloon, the *Marburg*, on another voyage. The centre of the rings was the point corresponding to the shadow of the eye, or of the camera objective. On calculating the radius r of the cloud drops from the angular radius of a ring, a divergence from theory was found on this, and other, occasions. Theoretically all the rings should give the same value for r, but the calculated value of r was found to diminish with the order of the ring outwards.

The Japanese observers are stated in the note to attribute the halo to reflected light from sun-images formed on the green blades by rays refracted through dewdrops. In the case of the cloud observations it seems necessary to assume reflection from portions of the cloud itself.

The difficult point, however, is to explain why the light thus reflected should be maximum in the direction of the sun, or, what is the same thing, in the direction of the observer. The fact that the ring surrounds the shadow of the observer's head seems to render such an assumption necessary. A single drop, as Prof. Richarz points out, does not give maximum intensity of reflection in the direction of the incident light. Dr. Richarz's explanation why the cloud as a whole should do so is simple and ingenious, and is applicable whether the sun's rays fall normally or obliquely to the surface of the cloud. Direct light only penetrates into the cloud (or assemblage of drops) when it finds a clear path, for if it strikes any drops on the way it will be scattered or diverted by refraction and reflection at their walls. If light which has so penetrated should then fall on the surface of a drop in the interior, it will be reflected in various directions, but only that portion of the reflected beam which returns the same way it came can find a clear path out again. Portions of the beam reflected in other directions will generally find their way blocked by intervening drops and be scattered. Hence the intensity of the reflected light will be maximum in the direction of the source of light, and the intensity will fall off rapidly with departure from that direction. The observer's head (or the balloon) cuts off the central portion of the sheaf of rays which he would see most brightly reflected, leaving only the peripheral portion visible.

To digress, I have a vivid recollection of one very foggy winter evening when I was wintering in a cottage on a wild part of the Cornish coast. Chancing to throw open the casement window of the sitting-room, I was for the moment quite taken aback to find myself confronted by a tall sinister figure looming up before the window. It was my own shadow thrown on the fog by a lamp left unshaded on a table in the room.

Perhaps I may take this opportunity to record another little optical observation of different character. Once—I think it was towards the close of the hot summer of 1908—watching, from the top of a cliff some 800 ft. high, the sun setting over the sea, I saw the upper half of the disc look like a double staircase; there were three or four distinct, almost rectangular, steps cut out of the limb symmetrically on either side. When most of the disc had sunk out of sight, the small portion remaining was suggestive of the lid of a teapot with a knob on top. Some lines of light cloud about the horizon showed the existence of horizontal stratification in the atmosphere, and the strange distortion of the solar limb was evidently due to refraction through horizontal strata with extraordinary sharpness of boundary and difference of density.

ALICE EVERETT.

Milbourne Lane, Esher, January 6.

"Rosa stellata."

IN 1898 Prof. E. O. Wooton described a remarkable new rose from southern New Mexico, giving it the name *Rosa stellata* on account of the stellate trichomes. The peculiar, mostly trifoliolate leaves, the leaflets with cuneiform bases and more or less truncate, sharply toothed apices, gave the plant an unusual appearance; while even the flowers, described as "large and showy . . . deep rose-purple," were not at all like those of the ordinary wild roses of the Rocky Mountains. Through the kindness of my friend, Prof. Fabian Garcia, I obtained some living plants of *R. stellata* from the original locality in the Organ Mountains. Some of these were sent to Dr. A. R. Wallace, who has grown them in England successfully; the others have been growing in Boulder, Colorado. Last year the plants in my garden grew exceedingly well, and were most attractive. Certainly if *R. stellata* can be generally used in gardens, it will be a valuable addition to horticulture, but it probably will do its best only in relatively dry climates. My wife attempted crosses with several other roses, and in one case was successful in getting good seed; what will result remains to be seen.

The fruit of *R. stellata*, as indicated by Wooton, is large, beset with strong slender prickles. Quite unlike the usual types of rose fruits, its walls are dense, not at all fleshy or brilliantly coloured, but corky. The orifice is very broad, with a diameter of 8 mm. The bright chestnut-red seeds, about 4 mm. long, are long-oval, not compressed, and therefore not at all angular. All this differs conspicuously from the fruit of typical Rosa.

R. stellata, however, is not the only plant of this type. Years before, Engelmann described *R. minutifolia* from Lower California, a plant with the same general characters. In recent times, Dr. Greene has separated part of Wooton's *R. stellata* as *R. mirifica*, and has added a fourth species, *R. vernonii*. Thus we have a compact group, which should, I think, form a distinct subgenus or genus Hesperhodos, with *stellata* as the type. All the species are of extremely restricted distribution, which may probably be explained by the fact that the fruits are not adapted to be eaten by birds.

The wide-open prickly fruit suggests that this may be a primitive form, as compared with true Rosa; but it is to be noted that the roses found fossil in the Miocene beds of Florissant, Colorado, belong to the true genus Rosa, not at all to Hesperhodos.

T. D. A. COCKERELL.

Boulder, Colorado, December 30, 1912.

A Lens or a Burning Glass?

IN the latest edition of Carpenter on the microscope at p. 119 occurs the following, evidently from the pen of the late Dr. Dallinger:—"There is in the British Museum a remarkable piece of rock crystal, which is oval in shape and ground to a plano-convex form, which was found by Mr. Layard during the excavations of Sargon's Palace at Nimroud, and which Sir David Brewster believed was a lens designed for the purpose of magnifying. If this could be established it would, of course, be of great interest, for it has been found possible to fix the date of its production with great probability as not later than 721–705 B.C. . . . we spent some hours in the careful examination of this piece of worked rock crystal, which, by the courtesy of the officials, we were permitted to photograph in various positions, and we are convinced that its lenticular character as a dioptric instrument cannot be made out. There are cloudy striæ in it, which would prove fatal for optical purposes, but would be even sought for if it had been intended as a decorative boss; while the grinding of the 'convex' surface is not smooth but produced by a large number of irregular facets, making the curvature quite unfit for optical purposes. In truth it may be fairly taken as established that there is no evidence of any kind to justify us in believing that lenses for optical purposes were known or used before the invention of spectacles."

While studying the evolution of fire-getting it occurred to me that this lens might have been used for obtaining fire from the sun; in other words, as a burning glass. It is well known that when the fires on the ancient altars happened by some accident to go out they had to be renewed by "pure" fire, obtained either by rubbing two sticks together or by concentrating the rays of the sun.

It would be an interesting investigation to see if this lens could be thus used. Of course, in the dull climate of England it might not work so well as in the sunny latitude of Nimroud, but the experiment would be worth trying, and by noting the extent to which the temperature was raised a good guess might be made as to its efficiency. JOHN PHIN.

Paterson, N.J., U.S.A., December 25, 1912.

"Primeval Man."

YOUR brief review of "Primeval Man" (NATURE, January 9, p. 512) devotes rather more than half of its space to the flat contradiction of two statements contained in a footnote. Your reviewer writes:—"That there was no connection between the Druids and the megaliths is absolutely unsupported by evidence. The idea is certainly older than the eighteenth century."

It is now commonly held that the Druids were an institution peculiar to the Celts, and there is no reason for tracing their origin to the pre-Celtic inhabitants of our islands. As the first wave of Goidelic or Brythonic invaders cannot have reached Britain much before 600 B.C., a gap of many centuries separates the Druids from the builders of the megalithic structures, which, by common consent, belong mainly to the end of the Neolithic or beginning of the Bronze age.

With regard to the popular notion connecting the Druids with the megaliths, the earliest printed reference appears in the enlarged edition of Camden's "Britannia," 1695. Here seven theories as to the origin of Stonehenge, &c., are cited, and the Druidic theory is quoted as being derived from a MS. paper of Aubrey. It is interesting to note in this connection that there is no instance of the words *druidic*, *druidical*, recorded in the "New English Dictionary" before 1755.

I am able to take a somewhat impartial view of the objections raised by your reviewer, as the footnote in question was written for me by the author of the articles, "Druidism," "Celt," and "Early Ireland," in the "Encyclopædia Britannica."

A. HINGSTON QUIGGIN.

88 Hartington Grove, Cambridge, January 14.

THE origin of the footnote is satisfactorily explained. Sir John Rhys's papers in the Transactions of the British Academy are strongly recommended. For literary information about the British Druids Welsh and Irish sources should be consulted. The material evidence bearing on primeval man, which was omitted from Mrs. Quiggin's book, is the astronomical testimony of the monuments, as interpretative both of Neolithic culture and of the real avocation of the Druid, whose nationality or race should be regarded as a secondary matter. Mrs. Quiggin's Celtic chronology should be revised. Mr. Common Consent, *alias* Commonly Held, is very apt to ignore evidence which he cannot quite follow, and what he follows generally is the angle of least resistance. He is very hard on astronomers and Druids—ancient astronomers.

Mediæval Welsh bards speak of bardic prophets as *derwyton*, modern Welsh *derwyddon*, "Druids." The traditional regulations for the erection of a stone circle for bardic purposes are prefaced with the statement that the regulations had been handed down from the time of the Welsh princes—that is, before the subjugation of Wales by Edward I. (see the section, "Voice of Gorsedd," in Welsh and English, in the printed collection called "Iolo MSS.," which may be consulted in most large libraries). Efforts have been made to show that such bardic documents are forgeries, with what motive is not stated. It has been proved, on the other hand, that the "forgers" did not understand their own alleged productions, and that their traducers are still more unaware of the meaning of the architectural principles involved in the traditional account (see NATURE for the last twenty years, and the second edition of Sir Norman Lockyer's "Stonehenge"). JOHN GRIFFITH.

X-rays and Crystals.

IT is not at all difficult to measure the ionisation produced by the radiation reflected by crystals, as indeed Prof. Barkla has already suggested. Using a sheet of mica and a pencil of a few millimetres diameter, I find it possible to follow with an ionisation chamber the movement of the reflected spot while the mirror is rotated. W. H BRAGG.

Leeds, January 17

ANTARCTIC BIOLOGY AND THE ROCKS OF WESTERN WILKES LAND.[1]

THE three last publications on the results of the Antarctic expeditions of the *Discovery*, *Scotia* and *Gauss* show that these works are approaching completion. The new contribution to the scientific results of the *Scotia* includes all the botanical reports except that on the phytoplankton, which may prove the most important. Of the ten memoirs in this volume, two deal with localities, Ascension and Gough Islands (lat. 50° S.), which are outside the Antarctic area. Seven of the memoirs are republished from various journals, while that by Mr. and Mrs. Gipp on the marine algæ is a compilation of their three papers with a rediscussion of some of the results. It is a great convenience to have these valuable memoirs collected into one volume; but it is unfortunate that the species founded in them are described in this work as "new species." Much trouble may be thus caused by the annual biological records again cataloguing these species, or by their being subsequently assigned to wrong dates.

[1] "National Antarctic Expedition, 1901–4." Natural History. Vol. vi. "Zoology and Botany." Pp. xvi+9+32+63+plates in text. (London: Printed by Order of the Trustees of the British Museum, and sold by Longmans and Co.; Bernard Quaritch; Dulau and Co., Ltd.; and at the British Museum (Natural History), 1912.) Price 16s.

"Scottish National Antarctic Expedition." Report on the Scientific Results of the Voyage of the S.Y. *Scotia* during the years 1902, 1903, and 1904. Under the leadership of Dr. W. S. Bruce. Vol. iii., "Botany." Parts i. xi. Pp. ix+153+plates in text. (Edinburgh: The Scottish Oceanographical Laboratory; Edinburgh and London: Oliver and Boyd; Glasgow: James MacLehose and Sons, 1912.) Price 23s. 6d.

"Deutsche Sudpolar-Expedition, 1901–3." In Auftrage des Reichsamtes des Innern. Herausgegeben von Erich von Drygalski. ii Band, "Geographie und Geologie." Heft vii. Pp. viii+617–662+2 plates. (Berlin: Georg Reimer, 1912.) Price 7.50 marks (Subscription price 6.20 marks.)

The first of the two new contributions in this volume is an interesting essay by Dr. Rudmose Brown on the problems of Antarctic botany. He agrees with Dr. Skottsberg in limiting the Antarctic area to south of 60° S. He retains Dougherty Island as existing, in spite of the failure of the latest attempt to find it. Dr. Brown refers to the striking poverty of the Antarctic in land plants. In the South Orkneys (lat. 61° S.) the expedition did not find a single flowering plant, whereas in 79° N. in Spitsbergen some of the land is carpeted with flowers of a hundred species. Dr. Brown attributes the poverty of the Antarctic flora to the mean temperature in the summer being below freezing point and to the flocks of penguins, which, in the absence of carnivorous animals, overrun the land. In his discussion of the origin of the Antarctic land flora, Dr. Brown remarks that the presence of an Arctic element in the mosses might appear to support the doctrine of bipolarity, which, he agrees with Dr. Skottsberg, has no botanical support. That most of the zoological evidence is also opposed to the theory is remarked by Mr. F. Jeffrey Bell in his interesting introduction to the last volume on the collections of the National Antarctic Expedition. Mr. Rudmose Brown explains the presence of the Arctic mosses by their transmission by sea birds, of which some species range almost from pole to pole. Some plants may have been introduced to Antarctica by wind; for Dr. Fritsch found in material from the South Orkneys the pollen of Podocarpus, which must have been blown from South America. Dr. Brown regards the whole Antarctic land flora as derived from South America, a conclusion which is supported by the absence of New Zealand plants from eastern Antarctica.

The second new memoir is by Dr. J. H. Harvey Pirie on Antarctic bacteriology. Levin has shown that many Arctic birds and seals are free from bacteria. Dr. Pirie, however, found that three out of the four species of seals examined and ten of the fifteen species of birds contained bacteria. His general results agree with those of Gazert, Ekelof and Charcot of the German, Swedish and French expeditions respectively, that Antarctic animals usually contain bacteria but may be sterile. Dr. Pirie found that the air, when carefully collected from the crow's-nest and the deep sea samples, was always sterile. In seven out of ten cases the surface water of the sea yielded bacteria. Denitrifying bacteria are, however, very scarce, and Dr. Pirie points out that the nitrogen so continuously added to the sea is eliminated by the action of these bacteria. Owing to the slight bacterial denitrification in the polar seas, plant and animal life is more abundant there than in the tropics.

Hence is explained the extraordinary abundance of individuals in the polar seas in spite of the relative poverty in species, a fact which is referred to by Mr. Jeffrey Bell in the new volume of the reports on the collections of the National Antarctic Expedition. He quotes Mr. Hodgson's remark that it was usual to take from ten to thirty thousand amphipods at a single haul, and Mr. Bell estimates that the collection included nearly ten thousand specimens of one schizopod. Mr. Bell refers to the two new species of Cephalodiscus and Mr. Hodgson's rediscovery of the ten-legged Pycnogonid as perhaps the most interesting of the biological results of the expedition. The volume includes three memoirs, a report on some young holothurians by Prof. MacBride, in which he suggests that these animals were derived from primitive echinoids, a hypothesis which appears less probable since Walcott's discovery of a Cambrian holothurian, which is much more ancient than any known echinoid. The second memoir is by Prof. Ehlers on the polychaets, and the last is by Prof. Fritsch on the freshwater algæ. This memoir is perhaps of less interest than the same author's report on the algæ collected by the *Scotia*, for Messrs W. and G. S. West have previously described the collection from South Victoria Land brought back by the Shackleton expedition. In the South Orkneys, in addition to the red snow which is familiar in Polar and Alpine regions, there is a yellow snow, due to a mixture of eighteen species of algæ and two of fungi. The colour is due to the numerous globules of fat. The general affinities of this flora are planktonic, and Dr. Fritsch suggested that it was carried ashore by the wind.

The last part of the volume on the geographical and geological results of the German south polar expedition contains a posthumous memoir by E. Philippi, the geologist of the expedition, on the intra-glacial material found near the winter quarters of the *Gauss*. The icebergs examined came from the east, and contained fragments of granite, gabbro, gneiss, crystalline schists, and a red quartzite, but no fossiliferous rock or representative of the "young volcanic" series. Icebergs were also examined eight miles west of the Gaussberg, and they contained similar rocks. Philippi concludes from the characters of the ice that it must have flowed over an irregular undulating land. The erratics collected by the expedition have been identified by Dr. Reinisch and include a similar but more varied series of rocks. They include granite and aplite, gabbro and gabbro porphyrite, many varieties of gneisses and hornblende schists, some of which are rich in pyrites, marble, quartzite, calc-silicate rock and sandstone. There is no true mica schist or phyllite. This association of rocks supports the view that western Wilkes Land is geologically a southern continuation of Western Australia. The third memoir in this part is a valuable study by Reinisch of the rocks collected in various Atlantic islands from the Azores to St. Helena. His report and analyses confirm the conclusion that the volcanic rocks of these islands mainly belong to the alkaline series, though, as Reinisch remarks, some of the basaltic rocks are intimately related to augite andesites.

J. W. G.

MODERN PUMPS FOR HIGH VACUA.

THE widespread researches on the phenomena in electrical discharge tubes, which form so important a feature of modern physics, directed much attention to the question of obtaining high vacua. In 1888, as Lenard tells us,[1] an efficient vacuum pump was by no means an essential part of the equipment of a physical laboratory: at the present time it emphatically is so. In the following a brief account will be given of the modern forms of the different types of pumps, especial reference being made, however, to a pump recently invented by Dr. Gaede, as it depends on a principle never before applied, and seems from present information more efficient than any of its predecessors.

All vacuum pumps except this latest one of Gaede's make use of the principle employed by Otto von Guericke in the first air-pump—that is, the intermittent separation and discharge of a fraction of the gas from the reservoir to be exhausted by means of a piston, which in the mercury pumps takes a liquid form. We can, in reviewing the modern forms, divide these pumps into three classes: the solid piston pump, the hand mercury pump, and the automatic mercury pump.

The solid piston pump has preserved much of its original arrangement of valves, but has been modified in the Geryk pump, which may be taken as a modern example, by the use of layers of a particular oil in the place of packing. The valves are always covered by the oil, which takes up all clearance, and hence leakage is largely avoided, but the vapour pressure of the oil, though very small, prevents the highest vacuum being produced; however, 0·0002 mm. of mercury can be attained. In a still more recent pattern, the "Rose" pump manufactured by Messrs. Cosser, there is no piston rod, the piston being of iron and moved by electro-magnets oscillating outside the pump cylinder.

The forms of hand mercury pump now used are all modifications of the well-known Toepler pump. One of the simplest and most successful is that devised by Antropoff, in which the usual bulb is replaced by one of cylindrical form arranged obliquely instead of vertically.

The desire to reduce the time and labour attaching to the hand pump has led to the construction of a large number of mercury pumps which can be operated mechanically; in experiments such as those of Prof. Wien on canal rays such a continuously running pump is a necessity. The most convenient of these are the various rotary pumps, of which the first was devised by Schulze-Berge, and of which Kaufmann in 1905 brought out a pattern which has been considerably used. The essential of this is an inclined spiral tube which rotates continuously; a thread of mercury running in it cuts off and forces out a fraction of the air at every rotation. There are two such tubes; the pump, though efficient, is somewhat fragile and complicated.

[1] Nobel discourse, 1906, p. 3.

The rotary mercury pump most in use at the present time is that of Dr. Gaede. It consists of an outer closed drum half filled with mercury, in which a second drum rotates. This drum is divided into chambers, which in turn become connected to the vessel to be exhausted; by the rotation they are filled alternately with gas and mercury, the gas being displaced into the outer space between the two drums and cut off from return by the mercury. The system is similar to the gas meter, only in this the moving gas effects the rotation, while in the Gaede pump the rotation sets the gas in motion. With this pump the pressure must first be reduced to a few millimetres of mercury by any rough preliminary pump, as otherwise the difference of pressure between the outside and inside of the rotating drum will become sufficient to drive the gas back into the drum again.

In the past year, however, Dr. Gaede described an air-pump depending on a new principle, which he calls the molecular air-pump. Maxwell assumed, and Knudsen has recently verified experimentally, that if a gas be in contact with a solid surface, the gas molecules are reflected from it in all directions independently of the angle of incidence, or "diffusely reflected." This is due to molecular irregularities of the surface. Gaede has shown that for pressures above 0·001 mm. of mercury the above assumption is not experimentally verified, and he attributes this to the formation of a film of adsorbed gas on the solid surface, which covers and conceals the molecular irregularities. The surface then presents only mechanical irregularities, and the result is that if a gas be travelling over a surface the molecules are preferentially thrown back in the direction from which they came, as they fall in general on small slopes of the irregularities facing their direction of drift. In both this case and that of diffuse reflection the new pump is effective, but the point is of interest in considering the theory of the pump, and it was considerations of this kind which led Gaede to its construction.

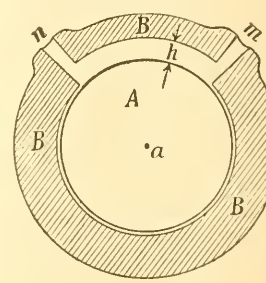

FIG. 1.—Principle of molecular air pump.

The new pump depends for its action on the dragging of the gas by a rapidly moving surface.[2] Consider a cylinder A rotating in a clockwise direction in a case B; in B there are two openings n and m connected by a slot (Fig. 1). The gas will be dragged by the cylinder from n to m, and in

[2] For the illustrations which accompany this article, we are indebted to the makers of the new pump—E. Leybold's Nachfolger, Cöln.

consequence a difference of pressure will be established between n and m which is proportional to the speed of rotation and the internal friction of the gas; the latter being independent of the pressure, the difference of pressure produced should be independent of the pressure. This is true when the pressure is relatively high; if it continued to be true down to the lowest pressures we should be able to create an absolute vacuum by exhausting initially with another pump at n to a pressure lower than the (constant) difference of pressure between m and n. When, however, we come to pressures below 0·001 millimetre of mercury this is no longer the case; the molecules are then diffusely reflected, and fly from one wall to the other without meeting other molecules. If the surface of the cylinder moved with a velocity greater than the molecular velocity we would obtain an absolute vacuum; such speeds are impossible in practice. However, at these low pressures the ratio of the pressures at m and n remains constant independent of the pressure, and it has been found that attainable speeds of revolution (8000–12,000 revolutions per minute) are sufficient to give a vacuum better than any hitherto obtained.

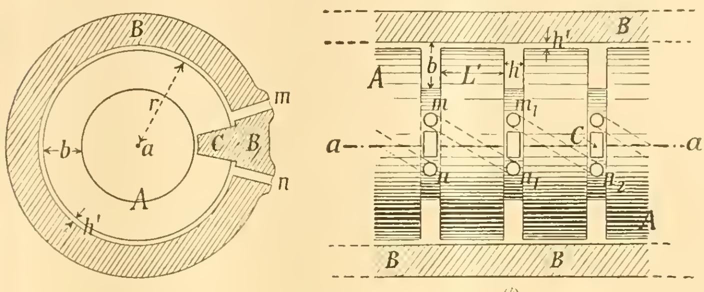

FIG. 2.—Construction of molecular air pump.

In practice the pump is constructed as indicated in Fig. 2 (*a*) and (*b*). Instead of cutting the slot in the case, the cylinder is grooved, and a tongue *C* from the case projects into the groove; this is equivalent to a very long slot in the case. For increased efficiency several parallel grooves are cut, and connected with one another so that the low pressure side of one is the high pressure side of the next (Fig. 2, *b*). The complete pump is shown in Fig. 3. A preliminary pump is needed to reduce the pressure to a few millimetres of mercury initially.

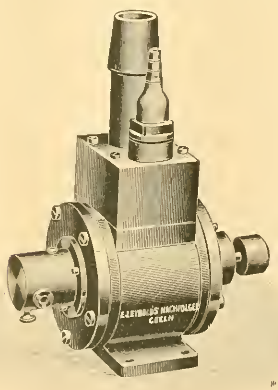

FIG. 3.—Molecular air pump.

A great advantage of this form of pump is that it deals with vapours as well as gases, as the low pressure part of the pump remains at low pressure. In other forms of pump the gases are compressed while being removed, and in consequence vapours condense which are afterwards brought back into the vacuum again. Without drying agents the new pump has produced a vacuum lower than any hitherto measured, 0·0000002 millimetre of mercury; this pressure was calculated by observing the ratio of the pressures in different grooves.

Very interesting are the measurements made by Gaede of the kinetic heat effect. Owing to the increased velocity of the molecules the temperature of the gas should be higher near the upper surface of the tongue *C* (Fig. 2) than near the lower surface, and by arranging a thermocouple in place of the tongue *C* Gaede has detected such an effect as soon as the pressure is low enough to allow the mean free path of the molecules to be larger than the dimensions of the groove.

A table of the exhaustion attainable with various selected pumps is appended.

Pump.	Pressure in millimetres of mercury.
Water pump	10
Ordinary piston pump	1
*Older Geissler pump	0·1
*Newer Geissler pump	0·01
*Sprengel pump	0·001
*Modified Toepler pump	0.00001
*Kahlbaum's automatic mercury pump	0·000002
Geryk oil-filled pump	0·0002
Gaede rotary mercury pump	0·00001
Gaede molecular pump	0·0000002

* Taken from Winkelmann's "Handbuch der Physik," I. The numbers must only be taken as very rough; for instance, it is very doubtful whether Kahlbaum's pump can give a better vacuum than Gaede's mercury pump (the figure for which is given by the Physikalisch-Technische Reichsanstalt).

E. N. DA C. ANDRADE.

NOTES.

WE regret to see the announcement of the death on January 10, in his sixty-first year, of Dr. F. Teller, chief geologist at the K. K. Geologische Reichsanstalt at Vienna, and member of the Vienna Academy of Sciences.

PROF. A. KEITH has been elected president of the Royal Anthropological Institute of Great Britain and Ireland, in succession to Mr. A. P. Maudslay. Mr. T. C. Hodson has been elected secretary of the institute, in succession to Mr. T. A. Joyce, who has become a vice-president.

M. B. BAILLAUD, director of the Paris Observatory, has been elected president, and M. H. Deslandres, director of the Meudon Observatory, vice-president, of the Paris Bureau des Longitudes for 1913.

THE death is announced, in his fifty-ninth year, of Dr. G. A. Gibson, of Edinburgh, who was a well-known authority on diseases of the heart. His work on "Diseases of the Heart and Aorta," published in 1898, established his reputation as a specialist.

THE Copenhagen correspondent of *The Daily Chronicle* reports that at a special audience on January 20 King Christian decorated Dr. V. Poulsen and Prof. P. O. Pedersen with the Medal of Merit in gold on account of the honour they have brought to Denmark by their work in connection with wireless telegraphy and telegraphones.

DR. E. M. KINDLE, for many years attached to the palæontological staff of the United States Geological Survey, at Washington, has accepted a similar position on the Geological Survey of Canada. Mr. Burling, for many years assistant to Dr. Walcott in the palæontology of the Cambrian rocks of North America, has also joined the technical staff of the Canadian Survey at Ottawa.

EXTENSIVE preparations are being made for the forthcoming meeting of the International Congress of Zoology to be held in the museum of the Oceanographic Institute at Monaco, March 25–30. Numerous collections from various expeditions and countries are being exhibited in the spacious halls of the institute. The aquarium at Monaco and the Russian Biological Station, Villefranche, are also expected to furnish interesting material for discussion during the congress.

A SPECIAL general meeting of the Royal Geographical Society was held on January 15 to consider, among other matters, the proposal to admit women as fellows of the society. The president (Lord Curzon of Kedleston) moved the resolution: "That the society approve of the election of women as fellows," and it was carried by 130 votes to 51. In future, therefore, women will be eligible for admission as fellows on the same basis as men.

ON Thursday next, January 30, Prof. B. Hopkinson will deliver the first of two lectures at the Royal Institution on recent research on the gas engine, and on Saturday, February 8, Sir J. J. Thomson will begin a course of six lectures on the properties and constitution of the atom. The Friday evening discourse on January 31 will be delivered by Mr. George M. Trevelyan, on the poetry and philosophy of George Meredith, and on February 7 by Sir John Murray, on life in the great oceans.

THE will of the late Mr. Rowland Ward, the taxidermist, directs that the trustees with respect to his charitable bequests shall expend 500*l.* per annum out of the income of his residuary estate, after the legacies and annuities specified have been paid, for a period of ten years in the purchase of specimens to be presented to the Natural History Museum, South Kensington. The residue of his estate is left in equal shares to such eight of fourteen selected charitable and other institutions as his widow shall choose. In default of his widow's selection within twelve months of the testator's decease, the whole of the fourteen institutions—which include the Natural History Museum—are to share equally.

MR. A. C. CLAUDET, whose death on January 17 will be widely regretted, was born on June 9, 1855, and was the eldest son of the late Mr. Frederick Claudet, of London and Cannes, the founder of the well-known firm of assayers and metallurgists. He was educated privately and at the Royal School of Mines, where he took the associateship in metallurgy in 1878. He was one of the best-known and most universally respected members of the mining and metallurgical community, and had been treasurer of the Institution of Mining and Metallurgy from its foundation in 1892 to the day of his death. He was president of the institution in 1906–7, and had also been a trustee for a number of years. At various times he also served on the council of the Institute of Chemistry, the Faraday Society, and on those of other scientific bodies. He took a keen and active interest in various educational movements to which he devoted a great deal of time, and which he generously assisted financially. These movements included the reorganisation, rebuilding, and equipment of the Royal School of Mines, the establishment of the Imperial College of Science and Technology, the Imperial College Union, &c., and he served on several committees connected therewith. He was an active member of the executive committee of the Bessemer Memorial Fund, from which the Bessemer Laboratory at South Kensington was equipped. He and Mr. Hennen Jennings, of Washington, D.C., established a "post-graduate grants fund," under the auspices of the Institution of Mining and Metallurgy to supplement the scholarships given by the institution to assist graduates to take practical courses in mines and works in the chief mining centres of the world, and many young engineers have been assisted in this way to bridge the period between college and their actual professional career with excellent results. His noble qualities of heart and mind are not so common as to make his death anything but a real loss to an unusually large number of friends, both personal and professional.

The Home Secretary has appointed a committee to inquire and report as to the conditions necessary for the adequate and suitable lighting (natural and artificial) of factories and workshops, having regard to the nature of the work carried on, the protection of the eyesight of the persons employed, and the various forms of illumination. The committee consists of the following members:—Dr. R. T. Glazebrook, C.B., F.R.S. (chairman), Mr. Leon Gaster, Prof. F. Gotch, F.R.S., Dr. J. Herbert Parsons, Mr. W. C. D. Whetham, F.R.S., and Sir Arthur Whitelegge, K.C.B. The secretaries of the committee are Mr. D. R. Wilson and Mr. C. G. Paterson. Any communications regarding the inquiry may be addressed to Mr. D. R. Wilson at the Home Office.

The committee which has been formed from representatives of several of the principal agricultural institutions of this country for the purpose of securing adequate British representation at the tenth International Congress of Agriculture, to be held at Ghent, Belgium, on June 8–13 next, is making an appeal for adherents to this important congress, and also for the contribution of papers on agricultural subjects. The subscription for members, who will receive the publications of the congress gratuitously, and have the right of taking part in the discussions, has been fixed at 20 francs (16*s*.) Subscriptions should be sent to the secretary, British committee (Mr. H. Chambers), Craven House, Northumberland Avenue, W.C., with whom those desirous of reading papers at the congress should communicate.

According to an article in *The Times* of January 16, the council of the Zoological Society has received, and accepted, an offer from Mr. J. N. Mappin, head of the firm of Messrs. Mappin and Webb, Ltd., to install in the gardens a series of terraces in rockwork for the better display of certain groups of the larger animals. In tendering a vote of thanks to Mr. Mappin for this munificent offer, the council intimated that the proposed structures are to be known as the Mappin Terraces. The site on which they are to be erected is the one where the special Malay and Nepalese collections were exhibited last summer; work is to be commenced at the earliest possible date, and it is hoped that the whole installation will be completed within a twelvemonth. That it will enhance the attractions of the ever-popular menagerie cannot be doubted, and it is expected that it will also conduce to the well-being and health of the animals. In making his offer Mr. Mappin expressed the hope that the council might see its way to allow shop-assistants to enter the gardens at a reduced payment on certain days, a suggestion which was favourably received by that body. The council has also accepted a gift of 1000*l*. from Sir J. Key Caird, Bart., for the erection of a new insect-house.

We regret to have to record the sudden death of Dr. O. T. Williams, hon. assistant-physician, Royal Infirmary, Liverpool, and lecturer on pharmacology and demonstrator of biochemistry in the University. Dr. Williams was cut off in the early prime of a life of great promise. He was only thirty-five years of age, and succumbed to an attack of acute pancreatitis after a few days' illness. During the past ten years he had published many important papers on the biochemical problems related to disease. His work was concerned chiefly with the biochemical problems of digestion and metabolism, such as the nature and constitution of the lipoids of tissues and organs, the lipoids of diabetic blood, the nature of the protein in albumosuria, abnormal fat assimilation associated with some diseases of the intestine, and certain biochemical changes associated with appendicitis. An account of Dr. Williams's published papers alone gives but little idea of the influence he was beginning to exert upon the progress of research in medical science in Liverpool, and in forming high ideals of the work of the physician as a scientific worker in the minds of the younger men in the city. His early death will be long lamented by many whose minds he influenced.

The death of Colonel F. Bailey, R.E. (retired), at Edinburgh on January 21, will come as a shock to foresters in many parts of the world. Colonel Bailey was one of the early pioneers when, forty years ago, the modern science of forestry was taken over by Englishmen from the Continent. He is best known as having for many years conducted the course of forestry at Edinburgh University. Several of his pupils now fill the most important forest appointments in the Empire. When a Captain in the Royal Engineers, Colonel Bailey was selected, so far back as 1871, to take charge of the survey branch of the Indian Forest Department. He held this important post until 1884. Latterly he also had charge of the Indian School of Forests at Dehra Dun. In 1884 he was appointed by the Secretary of State for India to take charge of the English students following the course of instruction at the Nancy Forest School. In 1887 he was decorated by the French Government in recognition of his forest services. He returned to India, temporarily, in 1887, and for some time acted as Inspector-General of Forests for that country. In 1907 failing health compelled the resignation of the Edinburgh lectureship; in July last the Senatus of the University conferred upon him the honorary degree of LL.D. Until his death he was hon. editor of the half-yearly forestry publication of the Royal Scottish Arboricultural Society, of which he was president in 1898. He was the author of papers on forestry far too numerous to mention here. As to his work in the field, he will be remembered as the framer of "working plans" for two important forest estates in Scotland, the first of their kind. The best known of these, that for Novar, is held to be well fulfilling his calculations and anticipations. He also helped Lord Lovat and Captain Stirling of Keir in the preparation of that most detailed and practical working plan of last year for the Glen Mor area on the Caledonian Canal.

The Horace Dobell lectures of the Royal College of Physicians were delivered by Dr. C. J. Martin, F.R.S., the subject being "Insect Porters of Bacterial Infections." The lectures form a very complete summary of our knowledge of the conveyance of typhoid fever and diarrhœa by house-flies, of plague by fleas, and of relapsing fever by ticks; lice and bugs are also referred to. Many details are given of the anatomy of the insects, and a full bibliography is appended.

THE January number of *Bedrock* (No. 4, 1913) contains the full text of Dr. Metchnikoff's Priestley lecture, "The Warfare against Tuberculosis," delivered before the National Health Society, an abstract of which was published in these columns. Dr. Eric Pritchard writes on "the milk problem," dealing with the question of the effect of heat as applied in pasteurisation and sterilisation of milk. He is satisfied that infants may be satisfactorily reared on freshly boiled milk and also on dried milk.

A PARASITIC fungus (*Empusa muscae*) of the house-fly has long been known, and its use has been suggested as a means of destroying flies. Hitherto the fungus has not been artificially cultivated, but Mr. Edgar Hesse now claims to have done this, and with his cultures to have infected and destroyed flies. The fungus attacks the house-fly (*Musca domestica*), the lesser house-fly (*Fannia canicularis*), and the stable-fly (*Stomoxys calcitrans*). It was formerly believed that the fungus attacks the fly from without, but Mr. Hesse finds that the spores are swallowed and probably germinate in the crop, and thence invade the tissues of the fly. The matter has been brought to the notice of the Local Government Board, by which it is being considered and examined. The evidence of the conveyance of disease germs by flies is complete, and the fungus might, therefore, be employed to destroy flies.

SIR RONALD ROSS delivered a lecture on medical science and the tropics at a meeting of the Royal Colonial Institute on January 14. He said that he cannot but feel that the reason why tropical Africa has not become civilised is due to the fact that the great tropical diseases affect not only immigrant Europeans but are almost equally disastrous to the natives. The ravages of malaria, yellow fever, kala-azar, dysentery, plague, and cholera were reviewed. The death-rate fell remarkably between 1903 and 1911, owing to knowledge accumulated by a band of enthusiastic investigators, who, however, are most inadequately remunerated. Sir Ronald Ross said that Britain gives probably less than 50,000*l*. per annum throughout the Empire for medical research, and yet medical research benefits some fifty millions of white subjects of the Empire. Mr. Austen Chamberlain, who presided, instanced as an example of the value of tropical medical research the fall in the invaliding rate of European officials between 1904 and 1911 from 63 to 25 per 1000. He made an earnest appeal for funds on behalf of the schools of tropical medicine.

THE University of California, in No. 4, vol. x., of its ethnological series, publishes an elaborate monograph on the tribe of Salinan Indians, which has been prepared by Mr. J. Alden Mason. The task of inquiry has been difficult owing to the lack of information regarding the stock itself, and the existence of similar conditions among the adjacent tribes. The Salinans occupy a position between the typically central culture of the northern groups and that of the Chamash to the south. Their general characteristics are a dependence primarily on vegetable food, chiefly acorns, a great stability of population, absence of gentile organisation, a weak development of the arts, of war, and of ritualism. In spite of these drawbacks, the present monograph, with its abundant details of their ethnology and culture, shows a considerable advance on our knowledge of the natives of California.

THE Queensland Museum has issued the first volume of a series of memoirs which promises to supply a valuable addition to our knowledge of the natural sciences and ethnology of Australia. The present issue opens with a paper on Papuan mummification by the director, Dr. R. Hamlyn-Harris, in which he describes two specimens from Torres Straits. The body was placed on a platform with a fire beside it, partly for the comfort of the spirit, and partly to assist in dispelling the noxious fumes arising during the process of desiccation. The corpse was then removed to the sea and cleaned, the interior being filled with pieces of the dried sago-palm. It was hung up to dry, and adorned by the insertion of pieces of Nautilus shell for eyes, the body was smeared with ochre and oil, and various ornaments were attached to it. When dried, it was fixed to the central pole of the hut, and after some years the head was made over to the widow, and the mummified corpse was taken to one of the gardens of the deceased and allowed to decay, or in some cases it was buried inside the hut.

IT is announced in the January number of *The Entomologist's Monthly Magazine* that, in consequence of having taken up his residence abroad, Lord Walsingham has felt compelled to resign his joint editorship of that journal.

FROM a distributional point of view considerable interest attaches to the identification by Dr. C. R. Eastman (Ann. Carnegie Mus., vol. viii., No. 2, 1912) of remains of doubly-armed fresh-water herrings of the genus Diplomystus in Tertiary deposits in Guinea. For the genus—in addition to several other localities—also occurs in a Tertiary formation on the Brazilian coast, and thus seems to indicate the prevalence of similar conditions during Tertiary times on the two sides of the Atlantic. The author discusses the bearing of the new fact on the theory of a former land connection between western Africa and eastern North America by means of an hypothetical "Helenis."

A COMPACT summary of the knowledge we now possess concerning the structure, origin, and economics of pearls and mother-of-pearl is given in a paper on "Perlen" contributed by Prof. E. Korschelt to *Fortschritte d. naturwissenschaftlichen Forschung* (Band vii., 1913). In sixteen short sections Prof. Korschelt gives an impartial account of the most important work of the last ten years. In connection with the origin of pearls, it is becoming quite clear from the work of Rubbell, Dubois, and Jameson that by far the greater number of pearls are formed around particles that are closely related to certain kinds of shell substance. We might, in fact, divide the causes of pearls into internal and external causes. The external causes include worm and other parasites and sand grains, and both are actually proved causes. The internal causes appear to be more interesting, and, so far as the pearls in the fresh-water mussel (*Margaritana margaritifera*) and possibly the Ceylon pearl oyster (*Margaritifera vulgaris*) are concerned, seem to be the more important. The paper is well illustrated, and as a short summary is admirable, though many sections undoubtedly require more detailed treatment.

DR. W. C. STURGIS has forwarded a copy of his recently published "Guide to the Botanical Literature of the Myxomycetes." This bibliography of an extensive and important group of Protista, which has been claimed alike by the botanist and the zoologist, gives the titles of a very large number of publications between the years 1875 and 1912, and though the compiler has confined his attention somewhat closely to citations from botanical writers, thus omitting a certain amount of valuable material in the fields of cytology and physiology especially, it will prove extremely useful to students of these organisms, whether botanical or zoological. The guide is issued by the Colorado College, as Science Publication, vol. xii., No. 11.

THE annual report of the Director of Agriculture for the Federated Malay States deals mainly with rubber, and shows an astonishing development of this crop. No fewer than 107,200 acres of land were opened during the year, while the total output of rubber was but little short of twenty-two million pounds, against twelve and a half million of the previous year; prices were also well maintained. Insect pests occur, but not to a serious extent; according to the entomologist, white ants (*Termes gestroi*) are decreasing, and the other pests can now be controlled. Fungoid diseases cause some trouble, especially that brought about by *Fomes semitostus*, but this is now amenable to treatment.

THE Meteorological Committee has recently issued the seventh edition of "A Barometer Manual for the Use of Seamen." The work was originally issued by the Meteorological Council in 1884, as a revise of the "Barometer Manual" prepared by Admiral FitzRoy, which had then been long out of print. Both these manuals attained great popularity; altogether about 25,000 copies of the revised editions were disposed of, this large supply being partly due to the adoption of the work as a text-book for mercantile marine examinations. The manual now under report (83 pp., large 8vo) was prepared in the marine division of the Meteorological Office under the superintendence of Commander Campbell Hepworth, C.B. (marine superintendent). It differs from the last edition mainly by the addition of certain paragraphs in the text, temperature conversion tables, and other minor details, and, like some of its predecessors (which have been referred to in our columns), is well illustrated by figures and by plates compiled from material in the possession of the office. The sections dealing with barometric pressure and its variations, with gales of the temperate zones, and tropical storms are very interesting and instructive, both for seamen and others, and, as stated in the title, the work is really "a text-book of marine meteorology."

IN the Proceedings of the Tokyo Mathematico-Physical Society, vi., 17, Mr. T. Terada considers the experimental fact that the velocities of earthquake waves fall short of the values calculated by hydrodynamical methods. His analytical work is devoted to examining whether this discrepancy can be accounted for by the yielding of the earth's crust, regarding the latter as a flexible bed resting on an inner fluid magma. The results show that the explanation is a plausible one, though the analysis involves a number of assumptions not realised in practice.

FOR some time past, the belief that Newton's law of gravitation is only approximate, and that the influence of a gravitative field depends on the time during which it has existed, has received increasing attention from physicists and astronomers. In a paper contributed to the *Wiener Sitzungsberichte* (cxxi., 1) Prof. G. Jaumann builds up a theory of gravitation based on a modification of Laplace's and Poisson's differential equations. This modification consists in the addition of an extra term proportional to the time-flux of the potential, and it leads to the result that in empty space the potential is propagated according to the same law as temperature in the diffusion of heat. The theory is applied to planetary motion, variation of latitude, and conditions of stability of the solar system.

WE have had an opportunity of experimenting with the "Rainbow Cup," which Mr. C. V. Boys showed a few months ago at the Royal Society soirée, and find it an interesting piece of apparatus. The cup has its lip horizontal, and can be spun about a vertical axis. When a soap film is placed on the top of the cup and the cup then spun, the film thins rapidly in the middle, and in a good light the display of colours is brilliant. By altering the direction of rotation coloured patterns can be produced which might be used as the basis of decorative designs. By continuing the rotation or by tilting the film a black spot can be obtained and a study of its motions under different conditions soon shows that it is thinner than any other part of the film. The makers of the "Rainbow Cup" are Messrs. J. J. Griffin and Sons, Ltd., Kingsway, W.C.

WE have received a copy of the second annual report of the work of the Radiological Institute attached to the University of Heidelberg, a report which appeared in part 43 of the *Elektrotechnische Zeitschrift* for 1912. The institute was founded in 1910, has Prof. Lenard for director, and a further staff of three assistant lecturers and demonstrators in addition to an instrument-maker and attendant. In the two years it has been in operation it has produced a long series of researches published in scientific journals in this country, as well as in Germany. These may be grouped under the following heads:—Absorption and secondary radiation of kathode rays, photoelectric effects, electrical conductivity of gases and of flames, phosphorescence and radio-activity, including its application to medical work. We wish every success to this active and progressive institute.

THE receipt of the notification of the Metropolitan Gas Referees for the current year serves as a reminder that the quality of the gas supplied to the County of London is subject to severe control. The threat of a monopoly caused by the amalgamation of various gas companies led to increased Parliamentary control, and commencing with the City of London Gas Act, 1868, there are several Acts dealing with the London gas supply, the latest being the London Gas Act, 1905. Subject to these Acts, the details of the methods to be used in gas-testing are left to three gas referees, who have to prescribe and certify the situation and number of the testing places, the apparatus and materials for testing the illuminating power, calorific power, purity and pressure of the gas provided by the companies. The notification of the gas referees gives the methods prescribed in detail. The controlling authorities (the London County Council and Corporation of the City of London) have also certain discretionary powers as to the times of testing, and these authorities also appoint the gas examiners.

MESSRS. CHARLES GRIFFIN AND CO., LTD., have published a tenth edition of an "Elementary Manual on Applied Mechanics," by Mr. A. Jamieson. Many new examination questions have been added, and the symbols agreed to by the International Electrotechnical Commission, held in Turin in 1911, have been included.

MESSRS. J. WHELDON AND CO., 38 Great Queen Street, Kingsway, W.C., have just issued a catalogue (No. 60) of books and papers on microscopical science in most of its branches. The catalogue includes a number of valuable works, both ancient and modern, and the classification makes it easy to find the works available in the various departments of microscopy.

OUR ASTRONOMICAL COLUMN.

NOVA GEMINORUM, NO. 2.—The photometric and spectroscopic observations of Nova Geminorum, No. 2, made at the Harvard and Arequipa Observatories, are discussed in Circulars 175 and 176 of the Harvard College Observatory.

Prof. Wendell's magnitude observations show several fluctuations, with maxima on March 14, 17, 23, 30, and April 5; the magnitude increased considerably during the night of March 14.

The spectra were taken between March 13 and June 5, 1912, inclusive, and are discussed by Miss Cannon; some are reproduced in the second circular. On March 13 the spectrum was not of the usual nova type, *i.e.* bright lines accompanied by dark lines; but was of the class F_5 (Procyonian) type, with slight variations, having dark lines only; a reproduction of the spectrum of Procyon is placed above the nova spectrum on the plate accompanying the circular, and shows the similarity very strikingly. Miss Cannon remarks on the fact that the earliest spectrum of Nova Persei (2) also lacked bright lines, and that these are the only two novæ of which the spectrum has been secured while the star's light was still rising to its primary maximum. The spectrograms taken on March 14 show the spectrum in a transitional state, the characteristic "nova spectrum" being fully developed on March 16. The bright band at K, faint on March 20, had disappeared by March 22, only a narrow dark line remaining; on March 27 a brightening in the region of the spectrum near $\lambda 4640$ was noticeable, the continuous spectrum was faint, and the dark hydrogen lines not clearly seen, but on March 30 both the continuous spectrum and the dark hydrogen lines were again more intense, the latter being distinctly double. A spectrum taken on May 10 is stated by Miss Cannon to show increased intensities for bands at $\lambda\lambda 4640$ and 5016, while a bright band appears on the less refrangible edge of $H\gamma$; this probably represents the appearance of the nebula line 5008 and the line which appeared during the nebula stage of previous novæ at 4365.

THE VARIABLE STAR 87, 1911.—From time to time we have referred in these columns to Mr. D'Esterre's notes describing a possible nova in the constellation Perseus. The star was conspicuous on plates taken by Mr. D'Esterre on November 13 and 21, 1911, but did not appear on three previous dates. Prof. E. C. Pickering now states, in Circular 176, that from an examination of the Harvard photographs, Miss Cannon finds that the star was of the eleventh magnitude on October 30, 1896, September 17, 1899, and January 28, 1902, but was not visible on sixty-eight other plates, including one taken, with sixty minutes' exposure, on November 3, 1885, which shows faint stars. Prof. Pickering concludes that this object is certainly not a nova, but appears to be a variable star with a large range which is bright during a relatively short portion of its variations; the period does not appear to be uniform, and he suggests that the object possibly belongs to the U Geminorum and SS Cygni class of variable stars.

THE TRANSIT OF MERCURY, NOVEMBER 14, 1907.—Prof. Donitch observed the transit of Mercury which took place on November 14, 1907, from a special station established at Assuan. The chief observations were spectroscopic, the spectra being taken with a special spectrograph, at the times of internal contacts, the slit coinciding with the sun's limb. The resulting spectra show no lines other than those of the solar spectrum, and lead Prof. Donitch to the conclusion that the planet does not possess an atmosphere extending beyond 15 km. from its surface; but for the present he hesitates to consider this conclusion as rigidly established. (*Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg*, No. 17.)

ASTRONOMICAL ANNUALS.—We have received M. Flammarion's "Annuaire Astronomique," for 1913, and the "Anuario" of the Madrid Observatory. In addition to its usual complete series of tables and ephemerides, the former contains useful illustrated reviews of the progress of astronomy and meteorology during 1912, several special articles, and a frontispiece showing six untouched photographs of the annular solar eclipse of April 17, 1912.

The "Anuario," besides the ordinary tables and ephemerides, has a popular article on new stars, a long article on the determination of azimuths in the field, an interesting review of solar physics, with special reference to the development of the spectroheliograph, and a *résumé* of the solar and meteorological observations of 1911 and 1912.

THE CLEVELAND MEETING OF THE AMERICAN ASSOCIATION.

THE sixty-fourth meeting of the American Association for the Advancement of Science was held in Cleveland, Ohio, from December 30, 1912, to January 4, 1913, under the presidency of Prof. E. C. Pickering, director of the Harvard College Observatory. The meetings of the association were accompanied, as usual, by the meetings of a large number of affiliated societies of national scope but of specific object. Twenty-five such societies met this year in Cleveland at the same time, and, in part, in close cooperation with the eleven sections of the American Association.

The meetings were held in the buildings of the Western Reserve University and of the Case School of Applied Science, which, with the exception of the Medical College of the Western Reserve University, stand upon the same campus in the eastern part of the city. The facilities for the meetings were admirable, and have seldom been excelled in the history of such meetings. There were about one thousand scientific men and women in attendance, or about one-half the attendance of the Washington meeting of last year, which is accounted for by the fact that while Cleveland is a large city and a manufacturing and commercial centre, it has not the large museums and scientific organisations of Washington. Nevertheless, some of the meetings were more largely attended than last year. The physicists, for example, and the psychologists, as well, held the largest sessions in their history, and most of the meetings were marked by exceptionally full programmes of great interest.

The growing tendency of the past few years to emphasise the work of the affiliated societies, more or less at the expense of the sections themselves, was in evidence, and the recent movement was continued whereby it has been arranged that when a national scientific society corresponding in its subject with a given section meets with the association, the sectional programme is abandoned except for a session of general interest, other papers offered to the section being transferred to the corresponding society. It is an interesting movement, and quite different from the general tendency in the British Association.

The titles of the addresses of the retiring vice-presidents of the different sections were as follows:—*Section A*, Mathematics and Astronomy, "The Spectroscopic Determination of Stellar Velocities, considered Practically," by Dr. E. B. Frost, Yerkes Observatory, Williams Bay, Wisconsin; *Section B*, Physics, "Unitary Theories in Physics," by Dr. R. A. Millikan, University of Chicago, Chicago, Illinois; *Section E*, Geology and Geography, "The Significance of the Pleistocene Molluscs," by Dr. B. Shimek, State University of Iowa, Iowa City, Iowa; *Section F*, Zoology, "Is it Worth While?" by Dr. H. F. Nachtrieb, University of Minnesota, Minneapolis, Minnesota; *Section G*, Botany, "The Scope of State Natural History Surveys," by Dr. F. C. Newcombe, University of Michigan, Ann Arbor, Michigan; *Section H*, Anthropology and Psychology, "The Study of Man," by Dr. G. T. Ladd, Yale University, New Haven, Conn.; *Section I*, Social and Economic Science, "The Comparative Measurements of the Changing Cost of Living," by Dr. J. P. Norton, Yale University, New Haven, Conn.; *Section K*, Physiology and Experimental Medicine, "The Function of Individual Cells in Nerve Centres," by Dr. W. T. Porter, Harvard Medical School, Boston, Mass.; *Section L*, Education, "Educational Diagnosis," by Dr. E. L. Thorndike, Columbia University.

In a number of instances, the meetings for the delivery of the vice-presidential addresses were arranged with following symposia often in joint session between one or more societies and sections on subjects closely related to the subjects of the vice-presidential addresses. In Section G (Botany), an interesting symposium was held on permeability and osmotic pressure, the leading paper on this title being presented by Dr. Jacques Loeb, now of Columbia University. To this discussion, Dr. H. C. Jones contributed a paper on the bearing of osmotic pressure on the development of physical or general chemistry; Dr. W. J. V. Osterhout discussed the permeability of plant cells; and Dr. B. E. Livingston discussed the part played by osmotic pressure and related forces as environmental factors.

Section B (Physics) and the American Physical Society presented as a joint interest programme papers on photographing and analysing sound waves, by Dr. D. C. Miller, of the Case School of Applied Science, Cleveland, Ohio; the reaction of the room on the source of sound, by Dr. W. C. Sabine, Harvard University, Cambridge, Mass.; and some points concerning absolute measurements of sound, by Dr. A. G. Webster, Clark University, Worcester, Mass.

The programme of Section I (Social and Economic Science) was largely devoted to conservation topics, one day being given to a symposium on the conservation of human life and health. The American Association of Anatomists and the American Physiological Society had especially long and interesting programmes. The American Society of Zoologists divided its programme into sections on the following topics: ecology and behaviour; comparative anatomy; comparative physiology; embryology and development; cytology; and genetics.

The American Chemical Society, an organisation of great strength, this year for the first time in many years has decided not to meet at the same time and place with the American Association. This is a new policy which will be given a trial. The Chemical Section of the association (Section C) will, it is hoped, continue its activities, but at the present meeting the address of the vice-president was not given. Owing to the absence, on account of ill-health, of the vice-president of Section D (Mechanical Science and Engineering), no address was delivered before this section.

At the opening meeting, the retiring president, Dr. C. E. Bessey, of the University of Nebraska, Lincoln, Nebraska, introduced the president-elect, Prof. E. C. Pickering, and addresses of welcome were delivered by Mayor Baker, of Cleveland, by President C. F. Thwing, of the Western Reserve University, and by Acting-President Comstock, of the Case School of Applied Science. President Pickering responded to these addresses of welcome, and was followed by Dr. Bessey with his address as the retiring vice-president, the title of the address being "Some of the Next Steps in Botany." This opening session was held in the large ball-room of the Hotel Statler, and was followed by a reception tendered by the local committee.

At the meeting of the general committee, Atlanta, Georgia, was chosen as the place of the next meeting during Convocation Week, 1913–14 (the week in which the first day of January falls), and Philadelphia was recommended as the place of meeting for the following year. Arrangements were made to make an earnest effort to bring about a large and important meeting in the summer of 1915 on the Pacific coast during the International Exposition to be held at San Francisco to celebrate the opening of the Panama Canal.

The following officers were elected for the year 1913:—President, Dr. E. B. Wilson, Columbia University, New York, N.Y.; vice-presidents: *Section A*,

F. Schlesinger, Allegheny Observatory, Allegheny, Pa.; *Section B*, A. D. Cole, Ohio State University, Columbus, Ohio; *Section C*, A. A. Noyes, Massachusetts Institute of Technology, Boston, Mass.; *Section D*, O. P. Hood, U.S. Bureau of Mines, Washington, D.C.; *Section E*, J. S. Diller, U.S. Geological Survey, Washington, D.C.; *Section F*, A. G. Mayer, Carnegie Institution of Washington, Washington, D.C.; *Section G*, H. C. Cowles, University of Chicago, Chicago, Illinois; *Section H*, W. B. Pillsbury, University of Michigan, Ann Arbor, Michigan; *Section I* (no election); *Section K* (no election); *Section L*, P. P. Claxton, U.S. Commissioner of Education, Washington, D.C. General secretary, H. W. Springsteen, Western Reserve University, Cleveland, Ohio; secretary of the council, W. A. Worsham, jun., University of Georgia, Athens, Georgia.

The following are the new secretaries of the sections elected for five-year terms:—*Section A*, F. R. Moulton, University of Chicago, Chicago, Illinois; *Section B*, W. J. Humphreys, Weather Bureau, U.S. Department of Agriculture, Washington, D.C.; *Section C* (no election); *Section D*, A. H. Blanchard, Columbia University, New York, N.Y.; *Section E*, G. F. Kay, Iowa State University, Iowa City, Iowa; *Section F*, H. V. Neal, Knox College, Galesbury, Illinois; *Section G*, W. J. V. Osterhout, Harvard University, Cambridge, Mass.; *Section H*, G. G. MacCurdy, Yale University, New Haven, Conn.; *Section I*, S. C. Loomis, New Haven, Conn.; *Section K* (no election); *Section L*, S. A. Courtis, Home and Day School, Detroit, Michigan.

SCIENCE AT RECENT EDUCATIONAL CONFERENCES.

TWENTY conferences were held in London during the first fortnight of this month, but we need only refer to the proceedings of the Public School Science-masters, the Teachers' Guild, the Assistant-mistresses, the Domestic Science Teachers, and the London County Council Conference of Teachers. It is true that the Headmasters' Conference met in December; but it is a remarkable fact that although individually the members are men of great force directed with earnestness, the vectorial addition of their forces when combined in conference yields a resultant which tends to zero. As their proceedings have no direct bearing upon science teaching, no further reference need be made to them here.

The usual meetings of the Association of Public School Science-masters (A.P.S.S.M.) were held at the London Day Training College, and were preluded by four lectures given by Dr. T. P. Nunn on the theory of science teaching, with special reference to the conditions in boys' schools. Dr. Nunn held that the aim of science teaching was to take the pupil along one of the main roads of human progress. The disciplinary value of science teaching was that they were treading the pathways of great minds, the function of the school being to bring the pupil into sympathetic relation with the character of human effort. He went on to deal with the characteristics of scientific method at different stages of its development; with the nature of induction and deduction, postulate, hypothesis, law and principle. The correlation of science with mathematics and other branches of the school curriculum was illustrated by applying the principles advocated to particular topics, and the skill and ingenuity of the applications were warmly applauded by an audience composed of experienced science-masters.

The main meeting opened with a presidential address by Sir Archibald Geikie, Pres.R.S., who gave a retrospect based on his personal observation of the progress of science in public schools during the last sixty years. An abridgment of the address was published in NATURE of January 16.

The first afternoon was devoted to the discussion of the aims and uses of school science societies, and the topics were assigned to opening speakers, who gave in each case a very useful account of the practical management on which success largely depends. General principles and methods were discussed, and next the subjects of field work in zoology and geology. The possibilities of a school astronomical society were brought forward by Mr. G. Hewlett (Rugby), and the Dulwich College Photographic Society was described with reference to details of organisation. It is a striking indication of the spirit animating members of the A.P.S.S.M. that no mention was made of the large amount of voluntary work which these societies place on the shoulders of the busy science-master; this voluntary burden is accepted as a matter of course, and nothing said. One who is merely an onlooker may direct attention to this spirit.

The discussion on practical examinations in science was unsatisfying. Mr. Berridge made some good points in his censure of the weaknesses of examiners; but the objections to abolishing practical examinations of matriculation (or lower) standard lacked a spokesman. Probably some profit would accrue to the crammer—at the expense of the schools. Mr. Berridge's suggestion that "a certificate from some responsible person, stating that a given number of hours have been spent in practical work, should be exacted from all candidates before they are allowed to sit for a paper in science," may be intended as a safeguard, but its operation is uncertain. It would be much easier for examining authorities merely to drop practical examinations, and there is a danger that this may be done without requiring Mr. Berridge's certificate. No resolution was put before the meeting, and the time for discussion was too short.

Valuable papers were submitted on the teaching of mechanics by Mr. A. W. Siddons (Harrow), Mr. C. E. Ashford (Dartmouth), and Mr. W. J. Dobbs. All advocated procedure from experiment and intuition to theory of increasing rigour; from concrete to abstract. The outcome of the discussions during recent years at the A.P.S.S.M. and the Mathematical Association will be, we hope, that the experimental and logical treatment will be unified. Formerly boys learnt "mechanics" in the mathematical class-room under one teacher, and another subject, also called "mechanics," in the physical laboratory, without correlation. We have got as far as correlation, and are now hoping for unity. Mr. G. F. Daniell urged that the teaching of density should be put into the background, and that specific volume should be given priority. He proposed the term "roomage" (already used in the Navy) in place of specific volume. The suggestions were favourably received. The value of the historical sequence in teaching chemistry was urged by the Rev. T. J. Kirkland. Mr. W. D. Eggar drew an amusing sketch of the historical sequence in electricity, but put in a strong plea for employing the method in leading the student to understand the work of Galileo, Paschal, and Newton. He claimed that to trace the development of ideas which culminated in Newton's discoveries was to open a new vista in the intellectual outlook, and ought to form part of any liberal education.

The association continues to increase in membership, and has just originated a useful piece of work by publishing a selected list of science books suitable for school libraries. There was the usual admirable exhibition of apparatus, the influence of which extends beyond the limits of the meeting and of the association. The Mathematical Association met in the same building, and it was unfortunate that arrangements were not made so that the two presidential addresses at least could be attended by members of both associations. Good service has been done by the Teachers' Guild, on the initiative of which thirteen associations met by agreement in the University of London and had a kind of British Association week of meetings. At one of the guild meetings Miss Sheavyn directed attention to the mode of entry into the higher grades of the Civil Service. Of the first hundred in the last competition fifty-nine scored chiefly in classics, twenty-nine in mathematics, and twelve in other subjects. (One gathers that science is not wanted or that proficiency in science is not esteemed as evidence of mental culture.) Miss Sheavyn regretted that in technical posts requiring qualifications in science, *e.g.* posts at the British Museum, the question of opening them to suitable women should not be considered, notwithstanding the difficulty experienced at times in getting applicants.

Miss L. M. Drummond, in her presidential address to the Assistant-mistresses in Public Secondary Schools, discussed "the scientific study of living things as an element in education." She said that they were urged by social reformers to teach girls certain definite biological facts, notably those of human physiology and reproduction; but there was too little appeal for real training in biological thought. In this age people did not set as high a value as they should on the energising power of ideas. Some knowledge of a living body was valuable, but she did not think it followed that a course of human physiology should always be introduced. If the school course included animal anatomy, more definite physiological teaching would find a natural place, and on such a foundation she would base teaching in hygiene. Training in scientific biology was a real and helpful preparation for entering sympathetically into the thought-life of the time.

A somewhat different line of argument was taken by Prof. Starling at the L.C.C. Conference. We hope to refer to this in a future article, to which also we postpone consideration of the discussion at the Association of Teachers in Domestic Subjects.

G. F. DANIELL.

PRIZES PROPOSED BY THE PARIS ACADEMY OF SCIENCES FOR 1914.

GEOMETRY.—The Francœur prize (1000 francs), for discoveries or works useful to the progress of pure and applied mathematics; grand prize of the mathematical sciences (3000 francs), for an improvement in the theory of functions of one variable which are susceptible of representations by trigonometrical series of several arguments, linear functions of this variable; Poncelet prize (2000 francs), for work in pure mathematics.

Mechanics.—Montyon prize (700 francs), for the invention or improvement of instruments useful to the progress of agriculture, the mechanical arts, or sciences; Henri de Garville prize (1500 francs), for original work in mechanics; Fourneyron prize (1000 francs), for a theoretical and experimental study of the question of combustion of explosion turbines.

Navigation.—The extraordinary prize of 6000 francs, as a recompense for work increasing the efficiency of the French naval forces; Plumey prize (4000 francs), for improvements or inventions contributing to the progress of steam navigation.

Astronomy.—The Lalande prize (540 francs), for the most interesting observation, memoir or work useful to the progress of astronomy; the Valz prize (460 francs), for the most interesting astronomical observation during the year; the Janssen prize (a gold medal), for a discovery or work representing an important advance in physical astronomy; the Damoiseau prize (2000 francs), for an improvement in Le Verrier's tables of Jupiter.

Geography.—The Tchihatchef prize (3000 francs), for the encouragement of naturalists of any nationality who have made explorations in the lesser-known parts of Asia; the Gay prize (1500 francs), for a study of the distribution of hydraulic forces in a mountainous region, with a description of the methods and instruments employed in this research; the Binoux prize (2000 francs), for work on geography; the Delalande Guérineau prize (1000 francs).

Physics.—The Hébert prize (1000 francs), for a treatise or discovery extending the practical use of electricity; the Hughes prize (2500 francs), for work contributing to the progress of physics; the Victor Raulin prize (1500 francs), for facilitating the publication of works relating to meteorology and physics of the globe; the La Caze prize (10,000 francs), to the author of works or memoirs contributing to the progress of physics.

Chemistry.—The Jecker prize (10,000 francs), for work in organic chemistry; the Cahours prize (3000 francs), for the encouragement of young workers in chemistry; the Montyon prize (unhealthy trades, a prize of 2500 francs and a mention of 1500 francs), for work rendering an art or trade less unhealthy; the L. La Caze prize (10,000 francs), for work in the field of chemistry.

Mineralogy and Geology.—The Fontannes prize (2000 francs), for a palæontological publication.

Botany.—The Desmazières prize (1600 francs), for a work on Cryptogams; the Montagne prize (1500 francs), for researches on the anatomy, physiology, development, and description of the lower Cryptogams; the De Coincy prize (900 francs), for a work on Phanerogams.

Anatomy and Zoology.—The Savigny prize (1500 francs), for the assistance of young travelling zoologists, not receiving Government aid, who occupy themselves with the invertebrates of Egypt and Syria; the Thore prize (200 francs), for the best work on the habits and anatomy of a species of European insect; the Cuvier prize (1500 francs), for a work on zoological palæontology, comparative anatomy, or zoology.

Medicine and Surgery.—The Montyon prize (2500 francs, mentions of 1500 francs); the Barbier prize (2000 francs), for a valuable discovery in surgical, medical, or pharmaceutical science, or in botany having relation to medicine; the Bréant prize (100,000 francs), for a means of curing Asiatic cholera; the Godard prize (1000 francs), for a memoir on the anatomy, physiology, and pathology of the genito-urinary organs; the Baron Larrey prize (750 francs), to a naval or army surgeon or doctor, for a work dealing with military medicine, surgery, or hygiene; the Bellion prize (1400 francs); the Mège prize (10,000 francs).

Physiology.—The Montyon prize (750 francs), for work in experimental physiology; the Philipeaux prize (900 francs), for the same; the Lallemand prize (1800 francs), for work relative to the nervous system; the Pourat prize (1000 francs), for a memoir on the origin of the anti-ferments; the L. La Caze prize (10,000 francs), for a work on physiology; the Martin-Damourette prize (1400 francs), for a work on therapeutic physiology.

Statistics.—The Montyon prize (1000 francs, two mentions of 500 francs).

History of Science.—The Binoux prize (2000 francs).

General Prizes.—The Arago, Lavoisier, and Berthelot medals; the Henri Becquerel prize (3000 francs); the Gegner prize (3800 francs); the Lannelongue prize (2000 francs), for men of science or their relatives in need of assistance; the Gustave Roux prize (1000 francs); the Trémont prize (1100 francs); the Wilde prize (4000 francs, or two of 2000 francs), for discoveries in astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics; the Lonchampt prize (4000 francs); the Saintour prize (3000 francs), for researches in the physical sciences; Henri de Parville (2500 francs); the Victor Raulin prize (1500 francs), for facilitating the publication of works relating to meteorology; the Houllevigue prize (5000 francs); the Caméré prize (4000 francs); the Jerome Ponti prize (3500 francs); the Bordin prize (3000 francs), for a study of the nature and origin of the gases and emanations from the terrestrial globe; the Serres prize (7500 francs), for works on general embryology applied to physiology and medicine; the Jean Jacques Berger prize (15,000 francs); the prize founded by Mme. la Marquise de Laplace; the Félix Rivot prize (2500 francs).

BRITISH MEDICAL SCIENCE AT THE GHENT INTERNATIONAL EXHIBITION.

ONE of the most important sections of the British exhibit at the forthcoming International Exhibition at Ghent will be an organised demonstration of the progress that has been made in this country in the scientific investigation of tropical diseases and of their prevention and cure. The exhibit has been carefully planned by a committee composed of members of the various schools of tropical medicine, and each school deals specially with certain diseases. The London School, represented on the committee by Dr. H. B. Newham, is dealing with beri-beri, cholera, filariasis, and guinea-worm. The exhibit of the Liverpool School, prepared by Dr. J. W. W. Stephens and Prof. Newstead, will be devoted to the subjects of malaria, sleeping sickness, yellow fever, and ankylostomiasis.

The Royal Army Medical College, under the direction of Lieut.-Col. Sir William Leishman, is undertaking exhibits of enteric fever and leishmaniasis, the former arranged in five sections to illustrate respectively the causation, diagnosis, dissemination, pathology, and vaccine treatment, the latter in three sections dealing with Indian kala-azar, infantile kala-azar, and Oriental sore. Malta fever is allotted to the Admiralty under the direction of Fleet-Surgeon P. W. Bassett-Smith, and plague to the India Office, represented by Sir A. M. Branfoot. Dr. Andrew Balfour, of Khartum, is preparing the exhibit relating to leprosy. In addition to the work of the schools, an exhibit will be sent by the Natural History Museum to illustrate the problems of natural history, such as life-cycles of the parasites, structure and life-histories of their insect-carriers, &c., specially connected with the study of tropical diseases.

In each case the disease will be considered, so far as possible, from the various points of view of distribution, cause, pathological effects, dissemination, treatment, and prophylaxis. The exhibits will comprise specimens, models, coloured drawings, or photographs of the parasites that cause the disease, and of the insects that transmit them, illustrating their structure and life-histories; charts, maps, and statistics showing the distribution and incidence of the disease, results of treatment, &c.; and specimens or models of apparatus used in treatment or prevention, such as, for example, models of mosquito-proof portholes and cabins on ships. In the case of beri-beri specimens of rice will be shown illustrating the causation of the disease, and in the case of sleeping sickness heads and skins will be exhibited of the species of antelope and other wild game which harbour the trypanosome.

The entire exhibit, the details of which are now practically complete, will be, it is hoped, a striking testimony to the wide range and great importance of the investigations upon tropical diseases that are being carried on in this country.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The prize of 50*l.* from the Gordon Wigan fund for a research in chemistry was awarded in the year 1912 to Mr. D. H. Peacock, for investigations on hydroxyhydrindenehydrazine and its resolution, 1 : 2 : 4-triketopentamethylene, the theory of molecular volumes.

The Senate authorised some time ago the erection of the eastern half of the forestry building, as soon as adequate funds have been provided. More than 4500*l.* has now been privately subscribed, and a grant from the Development Fund will enable the erection of the building to be taken in hand immediately. The cost of the contemplated building will exceed 5000*l.*, and the grant will therefore amount to 2500*l.* The forestry committee recommends that the grant by the Treasury of a sum of 2500*l.*, which is required to defray half the cost of the eastern portion of the forestry building, be accepted, and that the Vice-Chancellor be authorised to convey to the Development Commissioners the thanks of the University for the grant now authorised, and for their promise of a future grant when an extension of the forestry building will be required.

It is proposed to confer the degree of master of arts, *honoris causa,* upon Mr. G. Udny Yule, University lecturer in statistics.

OXFORD.—The Herbert Spencer lecture this year will be delivered by Dr. D'Arcy Wentworth Thompson, C.B., professor of natural history, University College, Dundee, at the Examination Schools, on Thursday, February 13, at 5.30. The subject of the lecture, which will be illustrated by lantern-slides, is "Growth and Form."

On January 28 Convocation will vote on a proposal to assign a plot of land in the University Park, to the east of the plot lately assigned for the erection of a new chemical laboratory, for the purpose of an engineering laboratory. It will be remembered that last term Convocation declined to sanction the allocation of a site for the latter purpose at the north-west corner of the park. A movement has been set on foot for acquiring land in various parts of the city for the future extension of University departments, and in particular for securing a site for the proposed engineering laboratory in the neighbourhood of Museum Road. It is understood that a sum of more than 1000*l.* has already been promised for this object, including a donation of 50*l.* from the Chancellor, Lord Curzon. On the other hand, it is urged, in a paper signed by many of the teachers of science in the University, that the Museum Road site is very unsuitable for the proposed laboratory, and it appears to be extremely doubtful whether, if the park site be refused, the other proposal will be accepted as an alternative.

ACCORDING to a recent regulation issued by the Minister of Public Instruction in France all students of foreign nationality who wish to pursue their studies in French universities with a view to obtain the licence or doctorate in law, the licence in science or in letters, or the doctorate of the university in medicine must produce (in the original) diplomas or certificates awarded to them by the universities or other institutions where they have pursued their studies and passed their examinations. These documents, which must be accompanied by a translation by a certified translator (*traducteur juré*), will be viséd and certified either by the Consul-General of France in the student's native country or by one of the representatives of that country accredited to France.

The following lectures will be delivered at the Lister Institute of Preventive Medicine on various dates from February 4 to March 18:—"The Early Bacteriological Work of Lord Lister," Prof. C. J. Martin, F.R.S.; "Various Products of the Tubercle Bacillus used in Diagnosis and Treatment and Current Views upon their Mode of Action," Dr. G. H. K. Macalister; "Some Recent Work on the Agglutination of Bacteria with Special Reference to Agglutination with Acids," Dr. J. A. Arkwright; (1) "Recent Work on Hæmolysis," (2) "Serum-fast Bacteria," Dr. J. Henderson Smith; "Lipoids," Dr. H. Maclean; "The Laws Governing Disinfection by Various Agencies," Dr. H. Chick; "The Chemical Action of Bacteria," Prof. A. Harden, F.R.S. The lectures are addressed to advanced students and others interested in the subjects discussed. Students of the University are admitted free, and others can obtain a card of admission on application to the secretary of the institute.

In the issue of *Science* for December 27 last, Prof. Rudolf Tombo, jun., examines the registration returns for November 1, 1912, of twenty-nine of the leading universities in the United States. Five universities show a decrease in the total enrolment, namely Cornell, Illinois, Iowa, Johns Hopkins, and Pennsylvania, while four institutions showed a loss in the total enrolment in the previous year. The largest gains were registered by Columbia (1069), California (733), Minnesota (515), New York University (488), Texas (475), Nebraska (391), and Harvard (303). In the previous year there were four institutions that showed a gain of more than three hundred students, namely California, Columbia, Cornell, and Ohio State. For 1912 ten institutions exhibited an increase of more than two hundred students in the autumn attendance, as against four in 1911. Of these institutions four are in the east, five in the west, and one is in the south. Of the universities dealt with the six with the highest total attendance are as follows:—Columbia, 9007; California, 6457; Chicago, 6351; Harvard, 5729; Michigan, 5620; and Cornell, 5412. As regards the number of students in pure science, Cornell continues to maintain its lead in this branch, enrolling 1419 students, as against Michigan's 1284, Yale's 1139, and Illinois's 965.

Mr. James Graham, secretary for education in Leeds, delivered on January 17, at the University of Leeds, a lecture on methods of preparation for the future life of our industrial army. In elementary education in this country, he said, we are not at present getting full value for the money spent, and this is to be attributed to the early age of leaving school and to local by-laws which allow the brightest pupils to leave before they have obtained full benefit from the education provided. The Government should, he said, take steps to raise the school-leaving age to fourteen years for urban districts throughout the country. This would make it possible to organise at the top of the elementary schools a special course of work, thoroughly practical in character, and likely to help in the production of the intelligent and adaptable type of boy now required in industry. He described an interesting educational experiment which is being made in Leeds in the establishment of day preparatory trades schools. These schools combine a preliminary practical training in trades with a continued general education for boys who have passed through the elementary school. The course covers a period of two years and aims at an all-round development of the boy's faculties in a practical manner. For such schools it is important, Mr. Graham insisted, to secure a teaching staff with practical experience of the workshop. For boys who enter some trade or industry directly they leave the elementary schools, a corresponding course of study is required between the ages of twelve and fourteen. The ultimate success of such a scheme lies to a large extent with the employer, and the Leeds employers are beginning to appreciate the value of the training given in the preparatory trades schools. During the years of youth and adolescence, he continued, supervision and guidance are needed, especially in regard to blind-alley occupations where comparatively high wages are paid for unskilled employment, often leading to the premature development of a spirit of independence in the boy and to the withdrawal of discipline and guidance on the part of the parent.

SOCIETIES AND ACADEMIES.

London.

Royal Meteorological Society, January 15.—Annual general meeting.—Dr. H. N. Dickson, president, in the chair.—Mr. C. J. P. Cave was elected president and Mr. F. Druce treasurer for the ensuing year.—Ordinary meeting.—C. F. **Brooks**: The snowfall of the United States. The author has collected the data available from more than 2000 stations for the fifteen years 1895–1910, and from the results thus obtained he has prepared a map showing the annual snowfall. The effects of topography, prevailing winds, storm frequency, and the location of the great lakes and oceans in and about the United States on snowfall are very apparent. In the first place, the western coast ranges, the Sierra Nevadas and Cascade ranges, lying in the path of the prevailing westerlies blowing from the Pacific Ocean, bring excessive snowfall (in many places exceeding 400 in. per year) on their western flanks. The dry interior basin just to leeward of these mountains has very little snowfall, except where mountains rise above the general level. The great Rocky Mountain chain again brings copious snowfall (exceeding 100 in. per year in a great many places, from Idaho and Montana south to northern New Mexico, and in some places in Colorado as high as 400 in. a year, and 300 in. per year in southern Wyoming). Again, in the lee of these mountains, the dry western prairies suffer deficient snowfall. On nearing the Great Lakes, snowfall increases, and on the south-east shores of each of the lakes, 80 to more than 100 in. of snow falls annually. The Appalachian Mountain chain brings the lines of equal snowfall far south, there being 50–100 in. in the mountains from Maryland to Maine. In northern New England frequent storms in winter cause a snowfall of more than 100 in. annually. In south-eastern United States snowfall occurs practically everywhere, except in extreme southern and eastern Florida and southern Texas. The Gulf Stream shows its influence as far as Cape Hatteras by bending the lines of equal snowfall far to the north.

Institution of Mining and Metallurgy, January 16.—Mr. Edward Hooper, president, in the chair.—L. H.

Cooke: (1) Some considerations on the specification of theodolites for mines. (2) Specification for a precision-theodolite. Having found in the course of a long experience that the greater number of theodolites catalogued by British makers, while not unsuitable for the purposes of the civil engineer and surface surveying in general, are not well adapted for underground work, more particularly in inclined deposits, the author has attempted to draw up a specification for a precision-theodolite specially suited for the requirements of the mining engineer. The outcome of successive endeavours in that direction was embodied in the two papers presented to the institution, the intention being to provoke discussion from mining men with a view to the ultimate drafting of a specification which should standardise the vital features and quality of a mine-theodolite suitable for working on lodes of no great thickness or inclination. As a preliminary, Mr. Cooke has formulated a series of twenty-four conditions which he regards as more or less essential to the production of a really useful instrument for the purpose required, his chief points being portability and readiness for immediate use, protection of the vernier plates and other vital parts from dust and dirt, absolute accuracy in reading, and all possible simplicity of construction and operation.—S. C. **Bullock**: Description of a modern lead concentrating mill, Broken Hill Junction North Mine, New South Wales. While not desiring to hold up the plant described in his paper as a model, the author showed how by pursuing a series of experiments, it was possible to improve a mill's output to a marked degree. The mill feed, which was originally treated as one class of ore, was divided into two sections, rhodonite and quartz, to undergo separate treatment in accordance with their respective physical characteristics, after the preliminary crushing and sorting. This system was devised as the outcome of exhaustive tests in sizing, screening, and concentrating, and the result of the new working has been a considerable increase in recovery. A further development alluded to in an addendum to the paper is the installation of a minerals-separation plant, which is intended to treat the crude zinc-lead ore after the jig lead has been extracted. J. H. **Levings**: The blast-roasting of sulphide ores. This paper related the practical experience of a working metallurgist in Tasmania, when the first smelter at which the Huntington-Heberlein process was used outside Europe was installed, in 1900, the Carmichael-Bradford process following a year later. A chief point of interest in the paper deals with the shape of the pots or roasting vessels, various experiments ultimately deciding the form which gave the most uniformly satisfactory results.

MANCHESTER.

Literary and Philosophical Society, January 7.—Mr. Francis Jones, vice-president, in the chair.—Dr. G. **Hickling**: A remarkable band-like cloud, observed on the night of December 24, 1912. It was suggested that the object observed was possibly due to cloud formation on the trail of dust in the track of a meteorite.—Dr. H. F. **Coward** and F. **Brinsley**: Vortex rings of flame in a hydrogen-air mixture.—R. F. **Gwyther**: The specification of the elements of stress. Part ii., simplification of the specifications already given (*vide* Manchester Memoirs, vol. lvi., No. 10); and part iii., an essay towards the reconstruction of the fundamental equations. Part ii. dealt with a general mode of reducing the number of arbitrary functions or the general stresses within a body from six to three. Part iii. dealt with the physical basis of the fundamental equations, and proposed a scheme differing from that generally accepted.

PARIS.

Academy of Sciences, January 6.—M. F. Guyon in the chair.—The president announced the death of M. Teisserenc de Bort and of M. Cailletet.—L. E. **Bertin**: Calculation of the increase of load or of speed obtained by increasing the dimensions of a steamer.—E. **Bouty**: The dielectric polarisation of the wall and measurements of dielectric cohesion; the retardation of the silent discharge.—L. **Maquenne** and E. **Demoussy**: The influence of the preceding conditions on the value of the respiratory coefficient in green leaves. The theory developed by the authors regards two stages as essential in normal plant respiration, introducing a new factor, the solubility of carbon dioxide in the cell juices.—A. **Calmette** and C. **Guérin**: A new contribution to the pathogeny of tuberculous infection. Healthy and tuberculous cattle were kept in the same shed for a period of eleven months, under conditions preventing infection by the lungs. All the healthy animals became tuberculous, and responded to the tuberculin test, although only half of them showed definite tuberculous lesions.—P. **Stroobant**: The distribution of spectroscopic double stars on the celestial sphere. Spectroscopic double stars are relatively much more numerous in the galactic zone than in the whole of the stars of the same magnitude, and this is due to the high proportion of helium stars among the binaries.—A. **Demoulin**: A general property of lines traced on a surface.—A. **Rosenblatt**: Irregular surfaces satisfying the inequality $p_g \geq 2(p_a+2)$.—Ch. **Müntz**: The direct solution of the secular equation and some analogous transcendental problems.—Georges **Giraud**: A class of transcendentals having a theorem of multiplication.—M. **Nörlund**: Linear equations of finite differences.—G. **Kœnigs**: The construction of the centres of curvature and principal planes of the envelope of a surface of a cylinder which rolls without slipping on another.—Jules **Andrade**: Experimental researches on the double cylindrical spiral.—Henri **Villat**: The flow of heavy fluids.—J. de **Boissoudy**: The equilibrium of a gas in a state of binary dissociation.—A. **Leduc**: Guldberg's law and the law of corresponding states.—O. **Dony-Henault**: The use of resistances of granulated metallic chromium for electrical heating. Powdered chromium, compressed between carbon plates, can be conveniently used as a resistance furnace, and permits of the use of low voltages. Temperatures above the melting point of quartz can be maintained.—Daniel **Berthelot** and Henri **Gaudechon**: The commencement of photolysis of ethyl alcohol, acetaldehyde, and acetic acid.—H. **Copaux**: The basicity of the tungsto-acids.—P. J. **Tarbouriech**: 2.2-Dimethyl*cyclo*heptanone.—A. **Fernbach**: The acidification of musts by yeast in the course of the alcoholic fermentation.—Marcel **Baudouin**: The lumbar vertebral canal in the anthropoid apes and in prehistoric man.—Pierre **Teissier**, Pierre **Gastinel**, and P. L. **Marie**: The passive vaccine immunity conferred by intravenous injections of variolic serum.—F. **Bordas**: The use of low temperatures in cryotherapy. A freezing mixture of solid carbon dioxide in alcohol or acetone is recommended for therapeutic work instead of pencils of solid carbon dioxide.—A. **Magnan**: The relations between feeding and the dimensions of the cæcum in ducks.—Pierre **Kennel**: Contribution to the study of the functions of the large tentacles in *Arion rufus*.—Jacques **Liouville**: The polymorphism of *Delphinus Cruciger*. M. **Desgrez** and M. **Dorléans**: The influence of the constitution of the purin bodies on their action towards arterial pressure.—A. **Railliet**, G. **Moussu**, and A. **Henry**: Experimental researches on the development of *Fasciola hepatica*.—Ch.

Pussenot: The lower Stephanian (Cevennes zone) in the axial Alpine zone. An attempt at the coordination of the various levels of the coal strata in the western Alps.—De Montessus de **Ballore**: Earthquakes and the phases of the moon. These appear to be unrelated.

January 13.—M. F. Guyon in the chair.—G. **Bigourdan**: Description of an apparatus for sending time signals automatically. A diagram is given of the time signal agreed upon by the recent International Conference, and form of commutator described by means of which such a signal may be sent automatically with high accuracy.—Lord **Rayleigh**: The resistance of spheres in air in motion. Referring to some experimental results published in a recent number of the *Comptes rendus* (December 30) by M. Eiffel, it is pointed out that the law of dynamical similitude as developed by Stokes and Reynolds for viscous liquids is applicable, at least as a first approximation.—R. **Lépine** and M. **Boulud**: Feebly combined sugar in the blood.—Jules **Baillaud**: An integrating opacimeter for stellar photographs. The Hartmann microphotometer is based on the assumption of a homogeneous photographic plate; a new form of photometer is described which is independent of this condition.—P. E. **Gau**: The most general transformations of partial differential equations of the second order.—Maurice **Janet**: The characteristics of systems of partial differential equations.—M. **Schwartz** and M. **Villatte**: The application of an optical method of coincidences to the transmission of time. The apparatus used consists of two optical telegraphs of the military type using acetylene, a Leroy electromagnetic pendulum with variable contact, and chronometers beating half-seconds. Two methods have been devised, one optical, the other partly optical and partly auditory. Results are given for distances between 6 and 45 kilometres, with an accuracy of 0·05 second.—Marcel **Brillouin**: The theory of black radiation.—M. **Costanzo**: The occlusion of the products of radium. Palladium occludes the products of the disintegration of radium. These phenomena can be applied to the estimation of radium.—Adrien **Guébhard**: The theoretical possibility of a reversible arrangement for the automatic reconstitution of the natural colours by projection.—E. **Mathias**, H. Kamerlingh **Onnes**, and C. A. **Crommelin**: The rectilinear diameter of argon. The densities of the liquid and saturated vapour at the same temperature of argon are given for eight temperatures ranging from $-125·17°$ to $-183·15°$. Argon follows the law of the rectilinear diameter approximately, but the deviations, although small, are too systematic to be assigned to experimental error.—A. **Perot**: The movement of the luminous centres in hydrogen tubes.—Ch. **Boulanger** and G. **Urbain**: Theory of the efflorescence of saline hydrates. The influence of temperature.—Marcel **Boll**: The relation between the velocity of a photochemical reaction and the incident radiant energy. The velocity coefficient of a photochemical reaction is proportional to the incident radiant energy, even if the reaction is bimolecular.—Nicolas **Czako**: The alloys of aluminium with vanadium alloys were prepared, containing from 1 to 80 per cent. of vanadium, and these were studied by the metallographic method. Crystals of Al_3V and AlV were identified, and indications of the existence of AlV_2 were obtained.—Jacques **Duclaux**: The elements of energy.—P. **Lebeau** and A. **Damiens**: A method of analysis of mixtures of hydrogen and gaseous saturated hydrocarbons, hydrogen, methane, ethane and propane. The method is based on the fractional distillation of the liquefied gases. Hydrogen and methane cannot be separated in this way, but a good separation of hydrogen from ethane and propane was obtained.—Ed. **Lasausse**: The fixation of the alkaline bisulphites on the salts and ester salts of the acetylenic acids. One or two molecules of sodium sulphite are fixed, giving mono- or di-sulphonates. The reaction has been studied with phenylpropiolic acid, methyl phenylpropiolate, and methyl amylpropiolate.—Paul **Gaubert**: Some compounds of cholesterol giving liquid crystals.—Lucien **Daniel**: New researches on grafting of Brassica.—J. **Stoklasa**: The influence of uranium and lead on vegetation. Minute proportions of nitrates of lead and uranium in the soil cause a distinct increase in plant growth.—M. **Marage**: The action of complex and intermittent sound vibrations on the auditive centres.—J. **Mawas**: The form, direction, and mode of action of the ciliary muscle in some mammals.—R. **Anthony** and I. **Bortnowsky**: A pleuropatagium of peculiar type in *Microcebus minor minor*.—H. **Agulhon** and R. **Sazerac**: The action of uranium salts and of metallic uranium upon the pyocyanic bacillus.—P. **Becquerel**: The influence of uranium salts and of thorium salts on the development of the bacillus of tuberculosis.—Ph. **Lasseur** and G. **Thiry**: Coloured cultures of bacteria considered up to the present as achromogens.—Em. **Bourquelot**, H. **Hérissey**, and M. **Bridel**: The biochemical synthesis of glucosides of alcohols with the aid of a ferment (α-glucosidase) contained in air-dried low yeast. α-Ethylglucoside has been obtained in a pure crystallised state biochemically.—Robert **Douvillé**: The influence of the mode of life on the sutural line of the Ammonites belonging to the family of the Cosmoceratideæ.—Alfred **Angot**: Value of the magnetic elements at the Val Joyeux Observatory on January 1, 1913.

BOOKS RECEIVED.

An Elementary Course of Magnetism and Electricity. By Dr. C. H. Draper. Pp. vii+86. (London: Blackie and Son, Ltd.) 2*s.*

Safety in Coal Mines. By Prof. D. Burns. Pp. 158. (London: Blackie and Son, Ltd.) 2*s.* 6*d.* net.

The Principles of Stock-breeding. By Prof. J. Wilson. Pp. vii+146 (London: Vinton and Co., Ltd.) 5*s.* net.

Journal of the Institute of Metals. Vol. viii., No. 2. Edited by G. Shaw Scott. Pp. ix+378+plates 32. (London: Caxton House.)

Die neuere Entwicklung der Kolloidchemie. By Dr. W. Ostwald. Pp. 23. (Dresden and Leipzig: T. Steinkopff.) 1 mark.

A New Geometry. Parts i. and ii. By S. Barnard and J. M. Child. Pp. xviii+315. (London: Macmillan and Co., Ltd.) 2*s.* 6*d.*

A Vertebrate Fauna of the Malay Peninsula from the Isthmus of Kra to Singapore, including the Adjacent Islands. Reptilia and Batrachia. By Dr. G. A. Boulenger. Pp. xiii+294. (London: Taylor and Francis.) 15*s.*

The Electron Theory. By Prof. T. Mizuno. Pp. 336. *In Japanese.* (Tokyo: Z. P. Maruya and Co., Ltd.)

Notions de Mathématiques. By Prof. A. Sainte-Lague. Pp. vii+512. (Paris: A. Hermann et Fils.) 7 francs.

Explosives. By Dr. H. Brunswig, translated and annotated by Drs. C. E. Munroe and A. L. Kibler. Pp. xv+350. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 12*s.* 6*d.* net.

Building Stones and Clay-products. By Dr. H. Ries. Pp. xv+415+lix. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 12*s.* 6*d.* net.

Human Physiology. By Prof. L. Luciani. Translated by F. A. Welby. Edited by Dr. M. Camis. Vol. ii. Pp. viii+558. (London: Macmillan and Co., Ltd.) 18*s.* net.

Achievements of Chemical Science. By Dr. J. C. Philip. Pp. vii+217. (London: Macmillan and Co., Ltd.) 1*s.* 6*d.*

A Medical and Surgical Help. By W. J. Smith. Revised by Dr. A. Chaplin. Fourth edition, revised. Pp. xviii+355. (London: C. Griffin and Co., Ltd.) 5*s.* net.

Elementary Manual on Applied Mechanics. By Prof. A. Jamieson. Tenth edition, revised and enlarged. Pp. xix+452. (London: C. Griffin and Co., Ltd.) 3*s.* 6*d.*

The Theory of Measurements. By Dr. A. de Forest Palmer. Pp. xi+248. (New York: McGraw-Hill Book Co.; London: Hill Publishing Co., Ltd.) 10*s.* 6*d.* net.

Handbuch der Morphologie der wirbellosen Tiere. Edited by A. Lang. Band iv., Lief. 1. (Jena: G. Fischer.) 5 marks.

A Handbook of Wireless Telegraphy. By Dr. J. Erskine-Murray. Fourth edition, revised and enlarged. Pp. xvi+442. (London: Crosby Lockwood and Son.) 10*s.* 6*d.* net.

The Manufacture of Iron and Steel. By H. R. Hearson. Pp. xi+103. (London: E. and F. N. Spon, Ltd.) 4*s.* 6*d.* net.

Le Problème Physiologique du Sommeil. By H. Piéron. Pp. xv+520. (Paris: Masson et Cie.) 10 francs.

Les Merveilles du Monde Sidéral. By M. G. Raymond. Fasc. ii. (Paris: G. Thomas.)

Die sanitarisch-pathologische Bedeutung der Insekten und verwandten Gliedertiere, &c. By Prof. E. A. Göldi. Pp. 155. (Berlin: R. Friedländer und Sohn.) 9 marks.

High School Ethics. Book One. By J. H. Moore. Pp. xiv+182. (London: G. Bell and Sons, Ltd.) 2*s.* 6*d.* net.

Mécanique appliquée. By Prof. J. Perry. Translated by E. Davaux, with additions, &c., by E. and F. Cosserat. Tome I. L'Energie Mécanique. Pp. vii+398. (Paris: A Hermann et Fils.)

Practical Agricultural Chemistry. By Prof. S. J. M. Auld and D. R. Edwardes-Ker. Pp. xxiv+243. (London: J. Murray.) 5*s.* net.

Elementary Physical Optics. By W. E. Cross. Pp. 312. (Oxford: Clarendon Press.) 3*s.* 6*d.*

Lost in the Arctic. By E. Mikkelsen. Pp. xviii+395+illustrations+map. (London: W. Heinemann.) 18*s.* net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 4.30.—The Metabolism of Lactating Women: E. Mellanby—(1) Colour Adaptation; (2) Trichromic Vision and Anomalous Trichromatism: Dr. F. W. Edridge-Green.—Transmission of Environmental Effects from Parent to Offspring in Simocephalus: W. E. Agar.—The Relation of the Islets of Langerhans to the Pancreatic Acini under Various Conditions of Secretory Activity: Dr. J. Homans.—Contributions to the Histo-chemistry of Nerve; the Nature of Wallerian Degeneration: H. O. Feiss and W. Cramer.—Onychaster, a Carboniferous Brittle-star: I. B. J. Sollas.—Herbage Studies. II. Variation in *Lotus Corniculatus* and *Trifolium repens* (Cyanophoric plants): Prof. H. E. Armstrong, F.R.S., E. F. Armstrong and F. Horton.

ROYAL INSTITUTION, at 3.—Birds of the Hill Country: Seton Gordon.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Use of a Large Lighting Battery in connection with Central Station Supply: F. H. Whysall.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—Recent Advances in Scientific Steel Metallurgy: Prof. J. O. Arnold

PHYSICAL SOCIETY, at 5.—The Electrical Conductivity and Fluidity of Strong Solutions: W. S. Tucker. The Resistance of Electrolytes: S. W. J. Smith and H. Moss.—The Recalescence of Iron Carbide: S. W. J. Smith and J. Guild.

MONDAY, JANUARY 27.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Morocco: Alan G. Ogilvie.

ROYAL SOCIETY OF ARTS, at 8.—Liquid Fuel: Prof. Vivian B. Lewes.

INSTITUTE OF ACTUARIES, at 5.—Some Aspects of the National Insurance Act, 1911. Part I. National Health Insurance: R. C. Simmonds.

TUESDAY, JANUARY 28.

ROYAL INSTITUTION, at 3.—The Heredity of Sex and Some Cognate Problems: Prof. W. Bateson.

ROYAL SOCIETY OF ARTS, at 4.30.—The Wood Industry in the British Dominions. C. E. W. Bean.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Canton-Kowloon Railway (Chinese Section): F. Grove and B. T. B. Boothby.—The Canton-Kowloon Railway (British Section): G. W. Eves.

WEDNESDAY, JANUARY 29.

AERONAUTICAL SOCIETY, at [illegible]0.—Stability Devices for Aeroplanes: Mervyn O'Gorman.

ROYAL SOCIETY OF ARTS, at 8.—Co-partnership: Aneurin Williams.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Formation of Usually Convergent Fourier Series: Prof. W. H. Young.—The General Theory of Elastic Stability: R. V. Southwell.—A Spectro-photometric Comparison of the Emissivity of Solid and Liquid Copper and of Liquid Silver at High Temperatures with that of a Full Radiator: C. M. Stubbs.—A New Analytical Expression for the Representation of the Components of Diurnal Variation of Terrestial Magnetism: G. W. Walker.—An Investigation into the Magnetic Behaviour of Iron and some other Metals under the Oscillatory Discharge from a Condenser: Prof. E. W. Marchant.

ROYAL INSTITUTION, at 3.—Recent Research on the Gas Engine: Prof. B. Hopkinson, F.R.S.

CONCRETE INSTITUTE, at 7.30.—The Settlement of Solids in Water and its Bearing on Concrete Work: Dr. J. S. Owens.

SOCIETY OF DYERS AND COLOURISTS, at 8.—The Possibilities of a Standard Light and Colour Unit: J. W. Lovibond.—A Simple Method for Detecting Silk, Cotton and Wool Fibres in Admixture in Textiles: W. P. Dreaper.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—The Poetry and Philosophy of George Meredith: G. M. Trevelyan.

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THURSDAY, JANUARY 30, 1913.

PROBLEMS OF SOIL FERTILITY.

Crops and Methods for Soil Improvement. By Alva Agee. Pp. xv–246 + plates. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1912.) Price 5*s.* 6*d.* net.

THE Pennsylvania State College, of which the author of this book is acting director, is one of the classical research stations of the United States, and one in which students of agricultural science are always interested. A book written by so prominent a member of the staff of the institution as Prof. Alva Algee is, therefore, sure of a welcome.

The volume before us is intended for practical men, and sets out in simple, straightforward language the essential facts which the college has been trying to inculcate. The four causes of infertility most common in Pennsylvania, as in other parts of the eastern States, are lack of lime, inadequate drainage, lack of organic matter and of plant food. These are, therefore, discussed in some detail.

Lack of lime is a perpetual source of trouble in the eastern States, and, it might be added, in this country as well. It has furnished the reason for some of the best-known work in the States, including the researches of Dr. Wheeler, at the Rhode Island Experiment Station, and the long-continued limestone-fertilised plots at State College. Advice and demonstrations in connection with this subject absorb much of the time and energy of the expert advisers. The simple directions given by Prof. Agee should go far to facilitate matters; the farmer is shown that his land needs lime when it tends to cover itself with alsike, sorrel, plantain and "red top" (*Agrostis alba*), and he is advised as to the proper method of application.

When lime or limestone has been added and the land drained, it becomes possible to grow clover. This has a two-fold advantage: it increases the amount of animal food produced on the farm and, therefore, the amount of saleable produce and of manure; and it also enriches the soil in nitrogenous organic matter. Considerable space is devoted to this latter effect and to alternative ways of bringing it about, such as the growth of lucerne, temporary grass mixtures, &c. This method of soil treatment is the basis of the plan worked out in the States for restoring fertility to their worn-out soils.

The improved land will now produce more maize than before. Dean Hunt has adduced evidence to show that the whole prosperity of the eastern States would be increased if the area of land under this crop were increased. Maize has twice the energy value of the other crops grown in the rotation, and it affords green food for dairy cattle and for fatting animals. Further, the use of artificial manures is justified on this improved land.

Such is the main outline of the author's thesis. How successful the method is in practice is shown by the high crop returns at the experimental stations. Pennsylvania contains some of the best farmed land in the States, but even the best of its farmers will be able to learn much from Prof. Agee's book.

E. J. R.

THE OAK AND ITS LORE.

The Oak: Its Natural History, Antiquity, and Folk-Lore. By C. Mosley. Pp. ix + 126. (London: Elliot Stock.) Price 5*s.* net.

THE editor of "White's Selborne" has given us a most dainty and chatty little volume on the "monarch of the woods." It is adorned on its cover with a panel of real oak, and furnished inside with beautiful illustrations specially produced for this work by the author. The book is divided into chapters on the oak in general; its economic value; historic and veteran oaks; the enemies and parasites of the oak; the oak in myth and folk-lore; and the oak in Holy Writ. On such a subject, the most important chapter, from a sentimental point of view, is the one on "Mistletoe-Oaks and Oak-Mistletoe." We learn, as leading facts, that the mistletoe grows on oak only "in odd instances." The known instances are given as the result of careful search and inquiry, and the only present instance, it seems, occurs in the neighbourhood of Eastnor Park, Herefordshire. The only English species of mistletoe is *Viscum album,* which grows extensively on apple-trees. In the south of Europe *Viscum aureum* or *Loranthus europaeus* grows in abundance on oak trees. Important information on the same subject is given by Sir Norman Lockyer in his "Stonehenge" (second edition, pp. 26, 27), and from the facts the following deductions seem natural and reasonable.

The mistletoe of the Druids was *Viscum aureum.* The Druids came from a south country where that species grows on the oak. The rarity of even *Viscum album* on oak in the north accounts for the extraordinary trouble and ceremony with which the Druids obtained the mistletoe for their purposes. As the apple-tree ranked next to the oak in the Druids' estimation, it is to be inferred that the apple-tree-mistletoe was deemed satisfactory for ordinary ceremonials.

Such facts and deductions constitute circumstantial evidence bearing on the theory that the Druids came from the south, while the British Celts came from the east; that they, or their representatives, were in Britain before the Celts—that is, in the Neolithic age or the age of the megalithic monuments; and that the Druids of the times of Cæsar and Pliny were priests or professors of a Celticised Iberic system. As evidence, the southern origin of the oak-mistletoe association would agree admirably with some syntactical peculiarities of British Celtic speech which are distinctly non-Aryan, and have been traced southward through North African dialects to ancient Coptic.

JOHN GRIFFITH.

FAGNANO'S MATHEMATICAL WORKS.

Opere Matematiche del Marchese Giulio Carlo de' Toschi di Fagnano. Pubblicate sotto gli auspici della Società Italiana per il Progresso delle Scienze dai soci V. Volterra, G. Loria, D. Gambioli. Volume Primo. Pp. ix + a–q + 474. Volume Secondo. Pp. xi + 471. Volume Terzo. Pp. xi + 227 + 2 plates. (Milano, Roma & Napoli: Albrighi, Segati e C., 1911 and 1912.) Price 40 lire (complete in three volumes).

GIULIO CARLO DEI TOSCHI DI FAGNANO was born in Senegal on September 26, 1682, and died there on May 18, 1766. In his boyhood he composed poetry; later on he was attracted to the study of philosophy and became a follower of Leibniz and Newton. At the age of fourteen he went to college at Rome, but his taste for mathematics only developed later, and he had to devote himself to its study without assistance out in Senegal. Although he became absorbed in his mathematical studies sometimes for days at a time, he also occupied himself with administrative work, and gave expert advice to the Pope Benedict XIV. regarding the safety of the cupola of St. Peter's at Rome. In return, the Pope promised to publish his "Mathematical Productions," but for some reason the promise was not fulfilled, and they were not published until 1750.

The best-known original work of Fagnano is that referring to the rectification of curves. "Fagnano's Theorem," relating to certain properties of arcs of ellipses, has frequently figured in English text-books, and is now recognised as the starting-point from which sprang the modern theory of elliptic functions. That such was actually the case is confirmed in the preface to these volumes, where it is stated that the work of Euler and Jacobi was initiated by the examination of a presentation copy of Fagnano's works, received by the Berlin Academy of Sciences.

This and other circumstances led the Italian Association for the Advancement of Science to undertake the publication, not only of Fagnano's "Mathematical Productions," but also of his unpublished writings and correspondence, the work being placed in the hands of Profs. Volterra, Gino Loria and Gambioli.

The first two volumes contain the "Produzioni," as originally published by Fagnano. The greater part of vol. i. is taken up with a treatise on the geometrical theory of proportion, which includes the whole of the propositions in Euclid's fifth book. In addition, we have papers on the solution of the cubic and biquadratic and on the mathematics of gambling, with special reference to lotto—a subject of considerable importance in Italy, where the Banca di lotto is a source of revenue to the State. The second volume contains a treatise on rectilinear triangles, and Fagnano's contributions to the study of analysis. These latter, unlike the former, consist of a series of short papers which perhaps constitute the most important of Fagnano's works. The third volume consists of work not included in Fagnano's *opus magnum*, namely, articles published after the appearance of the "Productions" in 1750, as well as correspondence. The collection of the material for this volume is due to Prof. Gambioli. A biography of Count Fagnano forms a fitting conclusion.

The series of volumes forms a useful addition to the archives of mathematical history. That the original work of this mathematician still opens up fields for investigation is shown by a recent paper on elliptic trammels and Fagnano points, contributed to *The Mathematical Gazette* for May and July, 1911, by Mr. Percy J. Harding.

G. H. B.

GEOLOGY IN THE SOUTHERN HEMISPHERE.

(1) *South African Geology.* By Prof. E. H. L. Schwarz. Pp. 200. (London: Blackie and Son, Ltd., 1912.) 3*s*. 6*d*. net.

(2) *Geology of New Zealand.* By Dr. P. Marshall. Pp. viii + 218. (Wellington, N.Z.: J. Mackay, Government Printer, 1912.)

(3) *An Introduction to the Geology of New South Wales.* By C. A. Süssmilch. Pp. xii + 177. (Sydney, N.S.W.: W. A. Gullick, Government Printer, 1911.) 5*s*.

THESE three books are written with an educational purpose, and are kept within the limits of size suitable for schools. They alike bear witness to the prominent place taken by geology in the outlook of settlers in the southern hemisphere. Where human history may be traced back into prehistoric anthropology through the brief period of two centuries, the earth itself, the land that is still in process of exploitation, makes a very natural appeal. The Geological Survey in such countries takes the place of an Academy of Inscriptions, and now the laboured memoirs of the surveys are being condensed for students who are to take their stand as citizens. South Africa, Australia, and New Zealand, armed with such accurate knowledge, will soon offer little field for those spirited romanticists, the company promoters of the mining world.

(1) Prof. Schwarz, however, is himself romantic. He stands among the prophets, and is apt to perceive the sunburst where some of us still remain doubtful of the dawn. A touch of adventure is imparted to the present volume by his unhesitating acceptance of the very attractive planetesimal hypothesis, and of the far more dubious conclusions of Brun in the volcanic field. We are invited by him to a well-planned arena, where nineteenth-century champions may be seen rolling in the dust. Apart from this, he sets out very justly to teach elementary geology in South Africa by South African examples. His treatment is so sound that we resent the introduction of the European Zechstein and Kellaways series, and so forth, in the table following p. 124, however necessary these trifles may still be in examinations conducted on traditional lines.

The author starts in his preface with the fact that brooks are unknown to his students, and by p. 34 we have a description of boulder-streams after torrential rains, on p. 35 we talk of vleys and vloers, and on p. 64 we realise, from a modern subtropical instance, the origin of our own "crystalline sandstones." The African climate permeates such chapters, and we must not complain if the pumpkin-like *roches moutonnées* on p. 43 and the treatment of glaciation on pp. 40 to 44 appear to European minds defective. There are some slips in the writing which suggest haste, as when a bore-hole is stated (p. 54) to be 6000 ft. thick, and when melilite-basalt (p. 63) is described without mention of the mineral melilite.

In an account of heat-weathering, which is very properly emphasised on p. 71, we are told that the corners of a block expose a larger surface to the sun than the flat sides. The matter is better expressed in Prof. Marshall's "Geology of New Zealand" (p. 46). Prof. Schwarz concludes with an account of the stratified series in the South African provinces and in Rhodesia, illustrated by maps and drawings of fossils, and full of interest for European as well as African readers.

(2) Prof. Marshall's book, coming so soon after Prof. Park's larger treatise, reminds us at once of the stratigraphical controversies that still await settlement in New Zealand. Dwellers in the British Isles find it hard to comprehend the vast series of rocks in other lands that may be devoid of fossil evidence; but it is equally hard to comprehend why an unconformity should be demanded as a proof of the distinction between two successive geological systems. This seems the main point with those who, like Prof. Marshall, reject the view that the Waipara series is Cretaceous, and insist on giving us a Cainozoic group which begins with Cretaceous types of life (p. 197). An author who believes "that too much attention has been paid in the past to the palæontological evidence" seems to mark out his systems on older grounds than those put forward by William Smith.

The book is very well illustrated by photographs, and, like that of Prof. Schwarz, introduces students to geology by means of the features of the home-country in which they live. Glaciers and recent volcanoes are brought in as present witnesses, and the geographer and geologist in other lands will welcome this convenient and well-printed volume. One does not demand a full treatment of rocks or minerals in a book that has another and a special aim; but the chemical formulæ on pp. 12 to 20 require a good deal in the way of correction and punctuation.

(3) Mr. Süssmilch's book, also in the same convenient *format*, is issued by the Department of Public Instruction of New South Wales. It presupposes a knowledge of geological principles, and brings together a large amount of matter that is distributed through official reports. This treatment allows of greater detail than can be introduced into the volumes on South Africa and New Zealand. We find pleasure, however, in comparing the account of the Glossopteris flora (p. 91) or the Palæozoic glacial beds (pp. 61 and 96) with the remarks of Prof. Schwarz on similar occurrences in South Africa; and there is no doubt that the three books should stand near together in our libraries. Through its design, that on New South Wales is naturally the most informing.

G. A. J. C.

OUR BOOKSHELF.

The Twenty-Seven Lines upon the Cubic Surface. By Prof. A. Henderson. Pp. vi+100+13 plates. (Cambridge: University Press, 1911.) Price 4*s.* 6*d.* (Cambridge Tracts in Mathematical Physics. No. 13.)

THIS volume is a record of an individual attempt to construct numerical models of the cubic surface, founded on the lines of the surface; it is carried through with great earnestness, and so far as possible with the simplest materials; its obvious sincerity cannot fail to be inspiring to anyone who will be at pains to understand it. It would be a mistake to criticise the earlier half of the book as if it were a treatise on the cubic surface; it is the author's assembling of his materials for the constructions which follow, and the very want of elaboration which it occasionally exhibits is a proof, if an incidental one, of the independence with which the author has carried out his research. Perhaps the analytical investigation of the double-six theorem, which occupies pp. 16 to 19, is an extreme case; a geometrical proof might have been given, though the author's is simple and self-contained.

The book is accompanied by reproductions of elaborate diagrams, carefully drawn to scale. They would have been more interesting if not so much reduced in size. There is a long bibliography of the general literature in regard to the cubic surface, which is likely to be useful. Under 1902 there should certainly be the entry, "Beziehungen der allgemeinen Fläche dritter Ordnung zu einer covarienten Fläche dritter Classe," by Th. Reye, *Math. Annalen*, Bd. lv. Also the paper of G. Kohn, "Ueber einige Eigenschaften der allgemeinen Fläche dritter Ordnung," *Wiener Sitzungsberichte*, Bd. cxvii., p. 66, should be referred to, and a recent paper by Prof. W. Burnside in the Camb. Phil. Proceedings, on double-sixes with projective transformations.

Medizinisch-chemisches Laboratoriums-Hilfsbuch. By Dr. Ludwig Pincussohn. Pp. xi+443. (Leipzig: F. C. W. Vogel, 1912.) Price 13.50 marks.

ONE cannot say that Dr. Pincussohn's book fulfils any real need, seeing that laboratory guides of the same nature are already numerous. The author was formerly assistant to Prof. Abderhalden, and is well known as an original worker in the field of physiological chemistry. The book he has produced is a very good one, and is specially useful because of the tables of physical and chemical data which occupy its last hundred pages. The introductory chapters deal with general chemical methods, and the remainder, as the title indicates, with that portion of the science which it is the fashion to call bio-chemistry. The analytical and other methods of research selected are up-to-date, and are described in a clear and interesting way. W. D. H.

Books that Count. A Dictionary of Standard Books. Edited by W. Forbes Gray. Pp. xx+315+lviii. (London: A. and C. Black, 1912.) Price 5*s*. net.

OF the fourteen sections into which this dictionary is divided, one deals with science, and some others are concerned with such kindred subjects as education, geography and travel, philosophy and sociology. The sections are necessarily incomplete, for the editor intends his lists chiefly for the use of young students and ordinary readers. The work should, however, be very valuable for reference to notable books in many departments of knowledge.

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.*]

Luminous Halos surrounding Shadows of Heads.

THE phenomenon referred to in a note in NATURE of December 12 (p. 419), as observed in rice-fields of Japan, can also be seen on grass when the sun is low in the sky. The presence of dew, I believe, increases the intensity of the halo, but it is perfectly distinct also on dry grass.

If the grass surface is near to the observer, a faint halo is seen to surround the shadow of his head, and this is more easily perceived if he is moving than if standing still; my attention was indeed first attracted to the phenomenon when bicycling.

In this mountain region I have frequently seen the halo projected on a grassy slope a mile or more distant, and under these conditions it appears as a circular or elliptical patch of light without the central shadow, the diminution of intensity due to the penumbral shadow of one's head being, of course, quite inappreciable at such distances. It is difficult to determine the size or shape of this patch, owing to irregularities in the brightness of the background; but I have been able to compare it with the nearly full moon rising immediately above it, and should judge it to be at least 2° in diameter, and probably elliptical in shape with the long axis vertical. The light appears to emanate from the grass itself, which apparently reflects more light in the direction of incidence than in other directions; it is certainly not due to dust or haze in the intermediate column of air. I am unable to say whether a smooth rock surface would give the same appearance, but a dense white cloud certainly does so, with the addition of a faintly coloured ring surrounding the white patch. This I presume is allied to the "Brocken spectre," seen when the illuminated cloud or fog is near to the observer.

The analogy of this elliptical bright patch opposite the sun with the Gegenschein is so striking that one cannot help believing both to be due to the same cause, and that matter outside the earth's orbit and beyond the limits of the earth's shadow reflects more sunlight in the direction of incidence than in other directions. That the Gegenschein usually covers a much larger angular area than the 2° patch seen on these hills may be accounted for by the much more favourable conditions in which it is seen, with a dark and uniform sky-background. J. EVERSHED.

Kodaikanal Observatory, South India,
January 4.

EXACTLY a month ago to-day, in the Betul district, Central Provinces, I had set out on field work at dawn, with my colleague, Mr. H. Walker, and two chaprasis (Indian servants). I happened to be watching our shadows as we passed along the edge of a field of young green wheat, when, to my surprise, I noticed a halo of light round the shadow of my own head and neck. Looking at the other shadows, I was still more surprised to see that only my shadow was invested with this halo. I directed the attention of Mr. Walker and the chaprasis to the phenomenon, and found that each could see a halo round his own head only. Whilst we were investigating the matter our camp passed on the march, and inquiries made both from our servants and from local people showed that none of them had previously noticed the phenomenon.

The conditions were obviously special, although frequently obtainable to one who deliberately set out with the purpose of finding them. The sun was at a low altitude on our left, and the wheat was soaking wet with dew on our right. The dew speedily dries up in the morning sun, and although I have kept on the look-out for this phenomenon during the past month I have never happened to pass a wheat-field again with the conditions of time, situation, and wetness repeated.

I had, therefore, intended writing to NATURE to inquire whether the occurrence of these halos had been previously recorded, and consequently was greatly interested to read the note on p. 419 of your journal (December 12, 1912) concerning *Inada no goko*, or halo in the ricefield. I have not seen the Japanese journal referred to, and consequently am not aware if Profs. Fuchino and Izu direct attention to the fact noted above, that each observer sees the halo round his own head only. This fact indicates that the observer perceives those elements of a narrow cylinder of the sun's rays enclosing his head that happen to be reflected back to his eyes by the dew-drops and wheat blades; the major portion of the cylinder of light is reflected back along the cylinder, and consequently a given observer is not in the line of vision for the halo round another observer's head. The explanation advanced by the Japanese observers that the halo "is caused by the reflected light from the sun-images formed on the green blades by the passage of the sun's rays obliquely through the dew-drops" is doubtless correct. I presume that their investigations show that the farther a drop is from the edge of the shadow of the head the smaller is the proportion of the light reflected from the sun-images that can reach the observer's eye: for the boundary of the halo is not sharp, the brightness diminishing somewhat gradually with distance from the shadow. Assigning to the head in the shadow the actual diameter of the head, I estimated the noticeably bright part of the halo as roughly 10 in. wide all round the head, dying out on the shoulders.

A close inspection of the green blades showed that at or near the tip of each blade was one pearl of dew, whilst the whole of the remainder of the blade was coated with a film of minute dewdrops. It is the minute drops that give rise to the major portion of the effect.

The fact that each observer sees only his own halo obviously precludes this phenomenon from having been the origin of the halos recorded in sacred writings round the head of Christ and others.

L. L. FERMOR.

Geological Survey of India, Camp, Korea State, Central Provinces, January 4.

Procryptic Coloration a Protection against Lions.

THERE has been some interesting correspondence in recent numbers of *The Field* on the question of the procryptic coloration of big game, some writers taking one side and some another in the controversy. Now although there is a certain amount of evidence, scattered through sporting literature, showing that some species of African antelopes and zebras are hard for human beings to detect in particular surroundings, there is, so far as I am aware, scarcely any testimony, based upon observation in the jungle, to prove that the sight of predatory carnivora is baffled in the same way by colour assimilation.

This question has such an important bearing on the theory of the evolution, through natural selection, of obliterative coloration that I venture to repeat the following story, told by Mr. F. C. Selous (*The Field*, January 18, p. 141), which I hold to be one of the most valuable contributions to the subject ever published, and worthy, as such, of being made known to a much wider circle of zoologists than is comprised by readers of *The Field*. Mr. Selous says:—

"I once wounded one [a lion]—a very savage lion, I think—which at once came round to look for me. I was sitting on the side of a large ant-heap, and no doubt my bare sunburnt arms and legs, and the dirty old shirt and towel in which I was dressed, assimilated well with the colour of my surroundings, for although the lion came and looked straight at me, he could not make me out. I had not had time to reload my single-barrelled rifle, but had a cartridge in my right hand ready to slip into the open chamber if the lion charged. But when he came towards me and then stood looking at me, I did not make the slightest movement, and he could not make me out, and presently turned and looked the other way. . . . I am perfectly certain that had I made the slightest movement . . . this lion would have charged."

Mr. Selous is a staunch opponent of the theory of the survival value of obliterative coloration in big game, and his experience, above recounted, gains force from the fact that it was described in an article in which he was combating the double claim that the equine and most of the ruminant mammals of Africa are procryptically coloured and are benefited thereby. But we shall probably have to wait many years before we get a more cogent piece of evidence in favour of the value to antelopes and other game of a combination of assimilative patterns with stillness.

R. I. POCOCK.

Zoological Society.

Animal Coloration.

AN article by Dr. Francis Ward, illustrated by the author's excellent photographs, appeared in the December number of *The Salmon and Trout Magazine*, which should not be missed by anyone who is interested in the problem of animal coloration. Without attempting to discuss or give any *résumé* of the paper, there is one point to which I should like to direct the attention of zoologists.

Most visitors to the Natural History Museum at South Kensington know of the ingenious device by which Dr. Thayer demonstrated his theory of the coloration of water birds. Two models representing ducks are so arranged and painted that one of them (A) is invisible until the observer comes close to the case; the other (B) is plainly to be seen from a considerable distance. A has been coloured dark above and light below, characteristic of most water birds, B the reverse. Hence it is suggested that the colours of aquatic birds are mainly protective against enemies on the shore, and to a certain extent against raptorial birds also. This theory has, I believe, met with much favour from ornithologists, even if they have not entirely accepted it.

Dr. Ward's results, however, seem to show that the coloration of flesh-eating aquatic birds is rather of an aggressive than of a protective nature, and that the light colour on the underside of such birds renders them invisible to their prey beneath the water. Certainly his photographs are distinctly striking, especially that of the heron and black-headed gull. It is much to be hoped that Dr. Ward will continue his observations "From the Fish's Point of View."

M. D. HILL.

Eton College, January 21.

The Reflection of the X-Rays.

MESSRS. LAUE, Friedrich, and Knipping's remarkable photographs taken through a crystal with X-rays have opened a new field of research. Mr. W. L. Bragg has shown that much stronger photographs are produced by a grazing reflection from mica. We have recently used the latter discovery to study the reflected beam electrically. We find that it resembles ordinary X-rays. Just like the primary rays it ionises air and helium and produces a soft radiation when it strikes metals. The variation of its ionisation in air with pressure is also similar. We have so far obtained effects as great as 1 or 2 per cent. of the primary beam. In some cases the measurements in helium were magnified by ionisation by collision.

The same absorption of the reflected beam was produced by aluminium, whether the rays passed through it before or after the reflection. In one case the absorption coefficient for either position was 6 $cm.^{-1}$, whereas for the primary beam it was 9 $cm.^{-1}$. This indicates that the character of the rays is unaltered by reflection, but that the amount of reflection increases with the hardness.

As Prof. Bragg has shown, the behaviour of the X-rays in connection with ionisation strongly suggests that their energy is concentrated as if they were corpuscular. Since the rays are reflected, they must be some kind of pulse with an extended wave-front, yet after reflection they retain their corpuscular character. Thus the energy of the X-rays appears to show the contrary properties of extension over a wave-front and concentration in a point.

H. MOSELEY.
C. G. DARWIN.

Victoria University, Manchester, January 21.

Emission of Particles by Heated Metals.

REFERRING to Prof. Valentiner's article on "New Facts in Physics," in NATURE of January 9, you note that Messrs. Reboul and Dr. Bollement have found that copper and silver eject particles at 500° C. in a vacuum, in air, oxygen, and carbonic acid. which forms deposits on the walls of the containing vessel. Pure silver, and several alloys having a chief content of silver, were found by me to emit particles or an emanation of some sort when heated in air to a bright red, but well below their melting points. The facts were observed during an inquiry to ascertain the cause of the sudden failure of the platinum pins of porcelain teeth, and were briefly noted in *The Dental Record*, September, 1911.

In the presence or proximity of silver at a red heat two kinds of effects on other bodies were observed: (1) a yellow to brownish-yellow staining on the surface of various porous "investments" (plaster of paris, pumice-stone, whiting, French chalk, asbestos, and mixtures of these) against which the silver or silver alloy had been heated; (2) porcelain was rendered weak and almost friable to a varying depth from the surface in contact with silver, the deteriorating effect penetrating to a depth of 3 or 4 mm. during half an hour's heating.

Gold, platinum, copper, zinc—singly or in combination—did not produce those effects, but when silver was present the staining was copious, and the weakening or "fritting" of porcelain in at least some degree always resulted. No analysis was made, but the inference seemed well founded that in those cases silver at a bright-red heat emitted something that gave rise to the effects noted.

D. M. SHAW.

Eltham, S.E.

Thermal Efficiency of Gas and Electricity.

OUR attention has been directed to a short paragraph in your issue of January 16 (p. 551) regarding the progress of electric cooking, in which the following sentence occurs:—"The present year should see a reasonably cheap and economical electric oven put on the market to compete with the everyday gas-cooker, which at present, on account of its low initial cost, still holds the field against the electric oven among the general public."

Please allow me to point out that it is not merely a question of comparative cost and upkeep of apparatus, but the more important point of comparative efficiency. The heat equivalent of one unit of electricity (costing at least one penny) equals 3410 British thermal units, while the heat equivalent of 33 cubic feet of gas (costing in London one penny) equals 16,500 British thermal units. No science can obtain from a given quantity of energy or fuel more than the maximum amount of heat it produces when completely consumed, and it is therefore apparent that electricity, so far as heat production is concerned, can never economically compare with gas.

W. M. MASON,
Secretary.

The British Commercial Gas Association,
47 Victoria Street, Westminster, S.W.,
January 21.

Research Defence Society.

IT is said that the fifth year in the life of any society is the critical period of its fortunes. The Research Defence Society was founded on January 27, 1908. To all who are interested—and who is not?—in medical research, we beg you to let us say that the society has its hands full of work, and only wants more money to do more work. Much has already been done, by lectures and by distribution of literature, to bring home to people the truth about experiments on animals in this country, and the great value of them, not only to mankind, but also to the animal world. The expenses of our society are heavy; but the good results of our work are extended far and wide. We have lately opened a bureau and exhibition at 171 Piccadilly (opposite Burlington House). We are exhibiting pictures, portraits, charts, anæsthetics and inhalers, germs in pure culture, tsetse-flies and mosquitoes, and so forth. This little exhibition, every day, and all day long, displays to "the man in the street" the facts of the case. We are the only society which is doing work of this kind; but, of course, it cannot be done without money. Our record for the last four years gives us the right to hope for a great increase of our membership, and of our funds, in the coming year.

DAVID GILL, President.
F. M. SANDWITH, Hon. Treasurer.
STEPHEN PAGET, Hon. Secretary.

21 Ladbroke Square, W., January 24.

Retinal Shadows?

IF, in the early morning, when the eyes are first opened, one looks at the white ceiling, branching lines are to be seen resembling blood-vessels. These figures only persist for about one second. It seems necessary for the eyes to be closed, and have a long rest, to show them clearly. In the daytime quite a long rest is necessary for them to be visible at all.

So far as I can judge they always have the same form. It would appear from this that they are really the shadows of the blood-vessels; but why they should only be visible for about a second after opening the eyes, and then only after a long rest, does not seem clear.

It may be that the phenomenon is well known, but, if so, I have not chanced to hear of it.

R. M. DEELEY.

Abbeyfield, Salisbury Avenue, Harpenden,
January 21.

A UNIVERSITY IN THE TROPICS.

THE TIMES of January 23 devotes one of its leading articles to the important question of the need of establishing a university in the tropics for the study of tropical agriculture. The subject is dealt with in a very interesting and forcible manner, and it is to be hoped that it may not be long before the proposal is realised.

At present, beyond the few facilities which exist at the Imperial College of Science and Technology, there is no place within the British Dominions where men who aspire to a tropical post, or have to deal with tropical estates, can learn more than a smattering of either the nature or magnitude of the problems which await solution. Yet men are constantly being sent out as agricultural officers to fill highly important and responsible posts, and they are expected to be able at once to cope with the difficulties which are presented from all sides.

Did we but stop to count the cost of our want of foresight in this matter we should realise that the expenditure in establishing a proper training centre in the tropics would long ago have been repaid by the increase of efficiency in the officers and the resultant improvement in agricultural operations.

The paramount advantage of a university or college of science established in some tropical colony would be that it would provide a centre where questions relating to soil, plant and animal breeding, plant and animal pathology, economic zoology, and various chemical and other questions could be investigated under tropical conditions by a highly competent professorial body, and where advanced instruction could be given to students—whose preliminary training had been received elsewhere—destined to fill agricultural posts in one or other of our tropical colonies. If the need of such an institution be admitted the question then arises, Where should such a university be stationed? Before suggesting an answer to this question it is necessary to point out that in view of the two-fold nature of the proposed institution, three points must be kept in mind. In the first place it should be situated in a colony offering the greatest possible scope for diverse agricultural pursuits; secondly, the healthiness of the colony should, so far as possible, be beyond reproach; and thirdly, the spot chosen for the university should be within easy access of the British Isles.

This last point is perhaps the most important one of all, since not only is it desirable on behalf of the students from home that the expenditure of time and money should not be unduly large, but also it is of paramount importance that the professors and lecturers should be able to have the opportunity of frequent intercourse with home, and so reduce to a minimum the possibility of stagnation and loss of vigour which might be liable to occur if personal intercourse with fellow-workers at home were rendered difficult by distance and expense.

This danger of stagnation would also tend very effectively to be obviated if the tropical university or college of science could be definitely linked with an institution at home. Such an institution should be either a university especially interested in agricultural matters or an institution of university standing, such as the Imperial College of Science and Technology.

If then it be agreed that the points which have been urged, in considering the requirements of an agricultural institution in the tropics, must be regarded as conditions essential to its success, it would seem clear that the site for the institution must be sought in the Antilles. Nowhere among these islands do we find all the requisite conditions so fully met as in the easily accessible and beautiful island of Trinidad.

THE NATURAL HISTORY COLLECTIONS OF THE BRITISH MUSEUM.[1]

TO those familiar with the natural history collections in the old British Museum in Bloomsbury the work of Dr. Günther must revive many pleasant associations of the 'fifties and 'sixties of last century—when the insect room was frequented by naturalists of note in various departments. Thus, besides the staff of the museum, which then included the brothers J. E. and R. Gray, Dr. Günther himself, F. Smith, and foreign naturalists, one met such men as Dr. Bowerbank, Mr. Busk, Dr. Carpenter, Mr. John Gould, and such ladies as the charming Mrs. Alfred Gatty—all eager to absorb as well as impart information. No marine laboratories then existed, so that marine, as well as terrestrial, natural history centred in the great museum. In the historical treatise heading the list, which no one could write so well as Dr. Günther, we are brought face to face with all the conspicuous additions to the vast collections, which in 1868 were close on a million and in 1895 two millions, the changes in the staff, the nature of their work, the financial allowances, and, more than all, the remarkable task of transporting the collections from the old museum to the new quarters in Cromwell Road.

Few have any notion of the vast stores in every department of zoology which have been assiduously collected in one way or another by the trustees, or of the labour entailed on the staff, for instance, by the receipt of 63,000 specimens of a particular group at once, especially if they were not carefully named and labelled. Besides the task of incorporating the rare or new species, duplicates have to be selected and treated differ-

[1] "The History of the Collections contained in the Natural History Departments of the British Museum." Vol. ii. Appendix. General History of the Department of Zoology from 1856 to 1895. By Dr. Albert Gunther, F.R.S. Pp. ix+109. (London: British Museum (Natural History); Longmans and Co., 1912.) Price 5s.

Catalogue of the Mammals of Western Europe (Europe exclusive of Russia) in the Collection of the British Museum. By Gerrit S Miller. Pp. xv+1019. (London: British Museum (Natural History): Longmans and Co., 1912.) Price 26s.

Catalogue of the Collection of Birds' Eggs in the British Museum (Natural History). Vol. v. Carinatæ (Passeriformes completed). By W. R. Ogilvie-Grant Pp. xxii+547+22 plates. (London: British Museum (Natural History); Longmans and Co., 1912.) Price £2 7s. 6d.

Catalogue of the Chætopoda in the British Museum (Natural History). A. Polychæta: Part I. Arenicolidæ. By Dr J. H Ashworth. Pp. xii+175+xv plates. (London: British Museum (Natural History); Longmans and Co., 1912.) Price 27s. 6d.

ently, whilst if the collection is unnamed or of great rarity, a descriptive account in a catalogue may be necessary.

Moreover, whilst the collections remained in Bloomsbury the great library was at the command of the staff, but the transference to South Kensington wholly altered the situation. Even before 1882–3, indeed, a departmental library was known to be a necessity for facility in working out the collections. Accordingly, in 1879–81, a commencement was made, and soon the library comprised 1700 titles, while at the end of the period embraced in Dr. Günther's history, and largely by his unceasing efforts, there were 10,036 separate works, or 16,238 volumes. The library is not only indispensable to the staff, but many zoologists outside—both British and foreign—have had their labours lightened by the conveniences thus afforded of consulting rare books, as well as by the courtesy of the staff.

But the care and custody of the nation's natural history collections form only a part of the duty of the staff, for, besides the select series for exhibition to the public, another for study by students (using this term in its widest sense) has to be arranged for, so as to leave those in the public galleries untouched; indeed, the exigencies of space, as well as the importance of the system, had caused Dr. Gray to adopt it so early as 1858. Moreover, descriptive catalogues, great and small, with plates and text-figures of every group, have to be prepared for publication—for example, the great, and to workers the indispensable, catalogue of fishes in many volumes, by the keeper himself (Dr. Günther). Single volumes of some of these publications, *e.g.*, that on monotremes and marsupials, by Mr. Oldfield Thomas, represent the labour of three years. Popular guides to the various galleries, on the plan proposed by the author of the history, that is, of a kind not only useful to every intelligent visitor, but in most cases of value to students of the department as well as to those in charge of other museums, have likewise to be prepared by the staff. Thus the collections of the great museum are utilised from various points of view.

As we read those terse and pregnant pages of Dr. Günther's, a procession of great naturalists and their collections passes before us in kaleidoscopic variety, and the familiar names of Sir Joseph Banks, Mr. Cuming, Col. Beddome, Dr. Jerdon, John Gould, A. R. Wallace, Mr. Hewitson, A. Hume, Messrs. Godman and Salvin, George Busk, Joshua Alder, Dr. Sclater, Dr. Gwyn Jeffrys, F. Day, Dr. John Anderson, and Lords Tweeddale, Lilford and Walsingham, and many others recall in each case a life-long devotion to particular groups.

Further, a long series of expeditions by sea and by land—from the Arctic to the Antarctic regions, as well as in the neighbouring waters and countries, besides the circumnavigating voyage of H.M.S. *Challenger*—have poured their riches into this great museum, which also received notable increments from the collections made by the East India Company, the Linnean Society, and the great Fisheries Exhibition of 1883. Mammals, from the huge whales, elephants and giraffes to the tiny marsupials, rodents and insectivores, find their place in this vast array, and so throughout the orders of mammals, the endless series of birds, reptiles, amphibians and fishes. The vast numbers of invertebrates, from cuttlefishes and shells, insects and crabs to corals, sponges and foraminifera, can only be estimated by the records in this volume. Not a few collections typify the Colonial possessions and dependencies of the Empire—from New Zealand to South America, Canada, Egypt, and India; whilst the native animals—land, fresh-water, and marine—have each a place in the series.

The period embraced by this treatise is of special interest, since it covers the erection of the fine Natural History Museum at South Kensington and the preparation of the plans for the furniture and fittings by the keeper, as well as the removal of the vast collections from their old quarters in Bloomsbury to their new premises in South Kensington. This task, carefully planned and skilfully carried out in about six months by Dr. Günther, without appreciable injury, is one that redounds to the credit of the keeper—whether in respect to the delicacy of many of the specimens, or the distance to be traversed in the streets of a busy city. The larger forms, perhaps, gave less anxiety than the dried and brittle corals, echinoderms and sponges, and, still more, the 52,635 jars and bottles of all sizes containing specimens in spirit. Dr. Günther thus well merited the congratulations of the trustees on this feat. In the material of the cases of the new museum a change from metal (recommended by the keeper) to mahogany was made by the trustees, probably on the grounds of economy; and for the same reason the reduction of the size of the separate building for the spirit collections, as Sir R. Owen, Dr. Gray and Dr. Günther foresaw, caused an extension of double the amount ten years later. A cetacean room had also to be improvised for these huge mammals.

Further, the system whereby the selected duplicates in every group, from primates to protozoa, are distributed to home and to Colonial museums was put in active operation, and not a few university and other museums have reason to be grateful to the trustees for this great privilege.

The three volumes following Dr. Günther's are typical examples of the important publications of the museum. The catalogue of mammals of Western Europe, by Gerrit S. Miller, of the United States National Museum at Washington, is a laborious and exact treatise, the origin of which is largely due to the efforts of Lord Lilford, Mr. Oldfield Thomas and Major Barrett-Hamilton. All the mammals except the cetaceans, seals and introduced forms, like *Simia sylvanus*, from the Rock of Gibraltar, are entered, and the manner in which the task has been executed is worthy of all praise in regard to both descriptions and figures. As an instance of modern nomenclature, *Orycto-*

lagus cuniculus would puzzle not a few zoologists. The second treatise is the catalogue of passeriform bird's eggs, by Mr. Ogilvie-Grant, so well known in the department, and it is the fifth volume of the series. Both in text and plates—of which there are twenty-two, all coloured—it is worthy of the reputation of the author. The value of such a work to all ornithologists is sufficiently obvious, and the trustees have to be congratulated on this addition to the series. The third catalogue, that of the Arenicolidæ, by Dr. J. H. Ashworth, is really a monograph of the family, containing as it does the results of years of labour by the author on the structure of the group, and admirably illustrated by text-figures and fifteen plates. By his devoted and varied researches on this family and its allies, the author is rightly regarded as one of the chief authorities on the subject, and this task for the trustees of the British Museum still further emphasises that view.

From the narrative of Dr. Günther, and the three works which form the latest additions to the long roll of important publications, it is clear that the great national zoological collection is one of which the country may justly be proud; and a tribute may well, in addition, be paid to the staff, whose courteous aid is ever at the disposal of zoologists of every nation. W. C. M.

PAUL GORDAN.

THE death of Paul Gordan, which occurred on December 21, has removed a mathematician of pre-eminent rank in his own particular field. When the calculus of invariants and covariants was started it was taken up with great vigour in Germany, and very important developments were effected by Aronhold, Clebsch, and Gordan respectively. Aronhold invented the symbolical method, Clebsch gave brilliant applications of it to geometry, and Gordan, besides collaborating with Clebsch, wrote numerous papers on the purely algebraic part of the theory.

Gordan's best-known, and perhaps greatest, achievement is his proof of the existence of a complete system of concomitants for any given binary form. In its original shape the proof was very laborious and difficult to grasp; even in the simpler form to which he and others reduced it, it is still very hard, and is not, perhaps, the proper and natural demonstration. However that may be, to have given the first strict proof of the theorem is an algebraic feat of the highest order. Gordan also worked out in detail the theory of transvection and "folding," ultimately arriving at formulæ which provide a sort of engine for establishing the syzygies connected with any particular binary form.

Among Gordan's other work may be mentioned his papers on finite groups, and in particular on the simple group of order 168, and its associated curve $y^3z+z^3x+x^3y=0$. His book on binary forms is very valuable, and easier to read than most of his papers. The joint papers of Gordan and Clebsch are admirable: for instance, the memoir on ternary cubics in Math. Ann., vi., should be read by everyone who has mastered the easier parts of invariant-theory.

Gordan was born at Breslau in 1837, ultimately became professor at Erlangen, and was a corresponding member of the Paris Academy of Sciences. M.

NOTES.

THE President of the Board of Agriculture and Fisheries has just appointed a departmental committee to advise the Board as to the steps which could be taken with advantage for the preservation and development of the inshore fisheries. The committee consists of Sir E. S. Howard, chairman of the Wye Board of Conservators; Sir K. S. Anderson, chairman of the Orient Steam Navigation Company; Sir S. Fay, manager of the Great Central Railway Company; Sir Norval Helme, M.P., a manufacturer; the Hon. T. H. W. Pelham, of the Harbours Department of the Board of Trade; Mr. Norman Craig, M.P.; Mr. W. Brace, a Labour M.P.; Mr. J. W. Beaumont Pease, vice-chairman of Lloyds Bank; Mr. C. Hellyer, a trawl-vessel owner; Mr. S. Bostock; and Mr. Cecil Harmsworth, M.P. Commerce and finance on the great scale are thus well represented, and no doubt the committee will be able to supplement the knowledge of the inshore fisheries which it may not possess by accepting evidence from those who do possess it. The interests of the inshore fishermen are opposed to those of the steam-trawling industry on one hand, and of the salmon fisheries on the other, and this is, no doubt, the reason why the only two fishery members of the committee are a prominent owner of steam fishing vessels and the chairman of a very important board of salmon fisheries. Those who know the highly technical occupations of the inshore fishermen will also know that the whole question of the decadence of these industries must by and by involve a scientific knowledge of the natural conditions under which inshore fishing is carried on. Yet the committee does not contain a scientific man, and it is unlikely that its members can acquire second-hand, from expert evidence, that knowledge of the "inwardness" of technical marine biology which can alone render their advice to the Board of permanent value.

SIR WILLIAM TILDEN, F.R.S., has been elected a corresponding member of the Imperial Academy of Sciences, St. Petersburg.

THE death is announced, at seventy years of age, of Prof. R. Collett, professor of zoology in the University of Christiania.

THE subject selected by Dr. A. J. Jex-Blake for his Goulstonian lectures, to be delivered before the Royal College of Physicians on February 25 and 27 and March 4, is "Death by Lightning and Electric Currents."

THE Mexican Minister has desired the Secretary of State for Foreign Affairs to announce in this country that the Astronomical Society of Mexico has decided, beginning from 1913, to offer a medal and diploma to any astronomer who discovers a comet. The medal will bear the name of "Carolina Herschel Medal."

THE ARCHDUKE RAINER, the oldest member of the Imperial Austro-Hungarian family, who died on January 27, at eighty-five years of age, owed much of his popularity to his keen interest in all forms of scientific and artistic activity. From an obituary notice in *The Times*, we learn that at the Vienna Academy of Sciences, of which he was curator, he never missed an important sitting, while the Austrian museums owed their development largely to his support.

THE interest in birds which has been aroused in this country to a very considerable extent of recent years continues to spread, and more and more use is being made of nesting-boxes. At an exhibition arranged by the Brent Valley Bird Sanctuary Committee, to be held in the offices of the Selborne Society at 42 Bloomsbury Square, W.C., on February 1–15, the tried forms and new designs of nesting-boxes may be seen, as well as other apparatus connected with the attracting of birds.

THE death is reported of Dr. G. A. Koenig, professor of chemistry since 1892 at the Michigan College of Mines. He was born in 1844 in the Grand Duchy of Baden, and was educated at schools in Lausanne and Karlsruhe, and at the Universities of Heidelberg and Berlin. He went to America in 1868, and held appointments at the Tacony Chemical Works, Philadelphia, and at the University of Pennsylvania, before joining the Michigan faculty. He discovered a number of new minerals, and took out patents for an assay furnace, and for the chlorination of low-grade silver and gold ores. One of his latest works was the preparation of artificial crystals of arsenides.

THE death of Prof. Augustus Witkowski, on January 21, at fifty-eight years of age, deprives the University of Cracow of a highly honoured member. Trained under Lord Kelvin (whose admirer he ever remained), Prof. Witkowski, after the tragic death of Wroblewski in 1888, was appointed to the chair of experimental physics in the Jagellonian University. In this position he did genuine service to the cause of science in Poland. In a series of papers he dealt with the thermodynamic properties of air and other gases at very low temperatures. The work, which appeared in the Bulletin of the Cracow Academy (and was partly reprinted in *The Philosophical Magazine*), is a model of patient and accurate research. He wrote a comprehensive treatise (in Polish), "Principles of Physics" (three volumes), which is highly praised for its lucidity and precision of statement. To Prof. Witkowski's efforts the University of Cracow owes its fine physical laboratory building, opened in March, 1912.

THE Year Book for 1912 of the Indian Guild of Science and Technology has now been published. It contains much interesting information of the progress made by the guild, the object of which, it will be remembered, is to cooperate in promoting the knowledge and application of pure and technological science in India, with a view to the improvement of the methods of economic production and the amelioration of the sanitary condition of the people. The president, Prof. A. Smithells, F.R.S., and committee of the guild are making a public appeal on behalf of the society, to enable them to extend and develop its work. Prof. Smithells will be pleased to receive donations. In addition to the annual report, the Year Book contains a varied selection of original papers on pure and applied science.

IN accordance with the recommendation of the Select Committee of the House of Commons on the Marconi Contract, the Postmaster-General has appointed a committee "to report on the merits of the existing systems of long-distance wireless telegraphy, and in particular as to their capacity for continuous communication over the distances required by the Imperial chain." The committee will consist of:—Mr. Justice Parker, chairman; Mr. W. Duddell, F.R.S., president of the Institution of Electrical Engineers; Dr. R. T. Glazebrook, C.B., F.R.S., director of the National Physical Laboratory; Sir Alexander Kennedy, F.R.S.; and Mr. James Swinburne, F.R.S. The committee has been requested, as desired by the Select Committee, in view of the urgency of the question, to report as soon as possible, and in any case within three months from the present date.

THE Zoological Society of Scotland, which, for the past three or four years, has been devoting itself to the establishment of a Scottish Zoological Garden of a type in which modern ideals may find expression, is now making rapid headway with its scheme. The council of the society gave its attention, in the first place, to the selection of a thoroughly suitable site, a matter in which, in addition to the expert knowledge of the eminent zoologists who form its vice-presidents, it had the guidance of Dr. Chalmers Mitchell, of London, Dr. R. F. Scharff, of Dublin, and Herr Carl Hagenbeck, of Hamburg. After a very careful consideration of all the available sites in the vicinity of Edinburgh, the council, a few months ago, decided on the estate of Corstorphine Hill House, lying close to the city on its western side. This estate, which extends to seventy-four acres in all, lies on the south-western slope of the hill, and, with its parks and gardens, its fine growing timber and outcropping rock, forms one of the most beautiful situations that could be chosen for the display of a zoological collection. The society holds an option to purchase it at the price of 17,000*l*., of which about 7000*l*. has been subscribed in little more than a month. The society wishes to raise 25,000*l*. before May next. The honorary treasurer is Mr. T. B. Whitson, C.A., 21 Rutland Street, Edinburgh.

KINEMATOGRAPHY in "natural colours" followed as a matter of course as soon as possible after the monochrome projection of moving pictures. We recorded a few years ago the first successful method by which this was accomplished as the result of the work of Mr. G. A. Smith in conjunction with Mr. Charles

Urban, two colours only being used, and the film passing at a double rate, so that the alternating coloured pictures blended as perfectly in the eye as in the non-coloured projection. Such films have been shown for a considerable time at the Scala Theatre and elsewhere, and are well known. Inventors have continued to be very active in this direction, and a demonstration of "chronochrome" films was recently given at the Coliseum, London. These films are in three colours instead of two, as theory indicates to be necessary. The triple pictures are produced by taking the red, green, and blue-violet constituents simultaneously in a single camera, and they are projected on the screen in a similar way, where they are superposed to form the coloured picture. There is no need to enlarge upon the advantage of three colours as compared with two, and if the mechanical difficulties that must have arisen have been fully overcome, as they appear to have been, this process must prove to be a notable advance in colour projection. It would seem, however, that the two-colour method referred to may continue to hold its own because of its greater simplicity.

In vol. xliv. of the Transactions of the New Zealand Institute, Prof. J. Macmillan Brown criticises the theory of Polynesian migrations advanced by the late Prof. Finck in the Transactions of the Royal Scientific Society of Göttingen for 1909. Prof. Finck's theory was largely based on philological considerations, and postulated a movement from the southern Solomon Islands eastward to the northern fringe of Polynesia. To this Prof. Macmillan Brown objects that, while there is a striking similarity between the languages of Polynesia, Melanesia, and Malaysia, there is a phonological gulf between the Polynesian dialects, on one hand, and the Malaysian, and, still more, the Melanesian languages, on the other. The same difficulty arises from a consideration of physical characteristics and culture. "We get," he objects, "into the region of the miraculous when we start a patriarchal, tribal, genealogy-loving, chiefly Caucasian people from a matriarchal, kin-divisioned, short-memoried Negrito island; and still nearer the miraculous when we start off, for nearly ten thousand miles of open oceanic wandering, a canoe expedition right in the teeth of the only constant winds, the trades that blow eight or nine months of the year, from an island that had only shallow shells of canoes, unfit for crossing anything but fairly narrow straits in calm weather or a favourable wind." These criticisms must be taken into serious account in any future attempt to settle the tangled problems of Polynesian wanderings.

A considerable addition to the Indian fresh-water fish fauna is made by Mr. B. L. Chandhuri in vol. vii., part 5, of Records of the Indian Museum. The new species, which are illustrated in four plates, are all referable to previously known generic groups.

In *The American Naturalist* for January Mr. E. L. Michael discusses the bearing of the Chætognatha (Sagitta) of the San Diego region on "Jordon's law," namely that, in the case of land animals, the nearest relative of any given species is to be found in a neighbouring district, separated by some kind of barrier. In the case of the pelagic Chætognatha this law is only partially true when tested by vertical distribution, allied species being isolated, but inhabiting situations remote from one another.

In the January number of *The Museums Journal* the Rev. Henry Browne points out (in a paper read before the Dublin Museums Conference of 1912) how museums may cooperate in placing the study of the classics on a more modern and satisfactory basis. This, it is suggested, may be accomplished by exhibits illustrative of the private and public life, art, &c., of the ancient Greeks and Romans, thereby combining education by means of tangible object with education by literature. Those who are of opinion that no Englishman can know his own language properly without a knowledge of the classics will welcome the suggestion. The natural history museum of St. Andrews University forms the subject of an article in the same issue by Prof. McIntosh.

So long ago as 1887 the late Prof. Marsh proposed the name *Eobatrachus agilis* for remains of a supposed frog or toad from the Como Jurassic of Wyoming. The two type-specimens were, however, never properly described or figured, and the determination has consequently been ignored. An examination by Dr. R. L. Moodie (*Amer. Journ. Sci.*, vol. xxxiv., p. 286, 1912) of these remains indicates that Marsh's diagnosis was perfectly correct, and that they really represent a tailless batrachian, and that, too, of a modern type. Indeed, it is suggested not only that it may belong to the family Bufonidæ, but possibly even to the existing genus Bufo. In stating that the American Jurassic toad is the only known Mesozoic tailless batrachian, the author appears to have overlooked the description in 1902 by Mr. L. M. Vidal (*Mem. R. Ac. Cienc. Barcelona*, ser. 3, vol. iv., (p. 203) of remains of a frog from reputed Kimeridgian strata of Montsech, N.E. Spain, referred to the Oligocene and Miocene genus Palæobatrachus, under the name of *P. gaudryi*.

The classification of the various forms of cultivated rice is a task that has been attempted by several botanical and agricultural writers, with varying degrees of success. An elaborate system of classification is set forth by S. Kikkawa in vol. iii., No. 2, of the Journal of the College of Agriculture, Tokyo, in a memoir of more than a hundred pages, largely occupied by closely packed columns of measurements, and representing a vast amount of labour. In framing his classification, the author lays down the sound principle that in dealing with cultivated plants it is necessary to take into account not only the relatively constant morphological characters, but also those characters which, though not very constant and often fluctuating considerably, may yet be of great importance for agricultural purposes. The memoir is accompanied by four plates of photographic illustrations.

Prof. C. J. Chamberlain has contributed to *The Popular Science Monthly* (November, 1912), an extremely interesting account of his recent round-the-world botanical excursion under the auspices of the

University of Chicago. The trip was undertaken for the purpose of making a scientific investigation of the cycads of the eastern hemisphere, and the principal places visited included the Sandwich and Fiji Islands, New Zealand, Australia, and South Africa. The cycads are a gymnosperm family, of which the remote ancestors were abundant in the Palæozoic age and the less remote ancestors were abundant and had a world-wide distribution in the Mesozoic. Only nine genera now remain, confined to tropical and subtropical regions, and even there are very local in their distribution. Of the four western genera, one ranges from Florida to Chile, two occur only in Mexico, and one only in Cuba; of the five eastern genera, one ranges from Japan to Australia, two are found only in Australia, and two only in South Africa. Prof. Chamberlain has during the last twelve years made detailed studies on the American cycads, and with the material now available intends to make a similar study of the Oriental forms, which should yield valuable results, especially since the Palæozoic ancestors of the family are becoming well known through the researches of various English palæobotanists, and the Mesozoic forms are being cleared up by Prof. Wieland, of Yale University.

THE interbasaltic iron ores and bauxites of the north-east of Ireland have long been objects of interest and speculation to geologists and others. The Geological Survey of Ireland is therefore to be congratulated on the production of its latest memoir, which is devoted entirely to these rocks. The new memoir is a well-illustrated volume of 220 pages, giving full details of these formations. Dr. Moss contributes a chapter on the plant remains, and in another chapter a large number of analyses have been collected. Two good colour-printed maps, showing the outcrops of the ores and clays and the associated basalts and rhyolites, are enclosed in a pocket. In an extremely interesting introductory chapter Prof. Cole discusses the nature and origins of these beds and the formation of laterite, bauxitic clays, and bauxitic iron ores in general. The typical downward succession within the interbasaltic beds in the county of Antrim is (1) *pisolitic iron ore*; (2) "*pavement*," a material varying from a siliceous iron ore to a lithomarge, with a false appearance of stratification, due to coloured streaks connected with the decomposition of residual blocks of basalt; (3) *lithomarge*, decomposed basalt retaining the original joint-structure, and often showing pseudomorphs after the felspars of the ground-mass. This passes down into a basic lava of the Lower Basaltic Series. The *pale bauxites* are derived from the rhyolites of the interbasaltic epoch. Some of this rock has been laterised *in situ*; elsewhere it has first been detrital. The main mass of the laterites and lithomarges of north-east Ireland are to be regarded as typical examples of soils and subsoils, formed under conditions now prevalent in regions of seasonal rains, near the equator.

IN *Symons's Meteorological Magazine* for January Dr. Mill gives an interesting account of the rainfall of the British Isles for the year 1912, prepared from a preliminary examination of part of the vast mass of data at his disposal. The following extracts may be useful in supplementing the summary already given in our columns (NATURE, January 16, p. 555), compiled from another source. The rainfall over the whole of the country was in excess of the average, with the exception of very limited areas; generally speaking, the least excess lay round the coast. England and Wales had an excess of 21 per cent., Scotland 7 per cent., and Ireland 9 per cent. The wet months were January to March (the latter having an excess of 63 per cent.), June (+81 per cent.) to August (+58 per cent.), and December (+43 per cent.). Of the remaining months, April and September had only about half the average. In England and Wales, April had only about one-fifth of the average, and in the south of England it was one of the driest months ever known; in Ireland September had only 23 per cent. of the average. There were four axes of high fall, exceeding 20 per cent. above the average, running parallel to one another across the United Kingdom from S.W. to N.E. The most important of these occupied the centre of England from Cornwall to Yorkshire, and reached the south coast also in Sussex. Within this area there was a strip stretching from Land's End to Norfolk where the rainfall was more than 30, and at places as much as 40 per cent. in excess of the average. For the British Isles generally the yearly excess was 14 per cent. above the average.

THE *Bulletin de la Société d'Encouragement*, cxvii., 3 (Paris, 1912), contains a short report on an ingenious chemical balance devised by M. A. Collot, in which the weights used in weighing are attached or detached by pressing buttons, the whole operation of weighing taking place after the case containing the balance has been closed. The sensitiveness is maintained constant by keeping the total load constant and removing the weights from the side on which the scale-pan containing the object is situated.

IN a short paper in *The Electrician* for January 10 Dr. Eccles shows how the efficiency of transmission from the sending to the receiving aërial in any system of wireless telegraphy may be calculated. He applies his method to the original plain aërial of Marconi, the first tuned aërial of Lodge, the recent coupled circuits of Marconi, and to an ideal system sending out a continuous train of waves. He comes to the important conclusion that the present systems of coupled circuits actuated by sparks have efficiencies of transmission about 90 per cent. of that which would be obtained by the use of a continuous generator of electric waves; hence the introduction of such generators can only lead to a small increase of the efficiency of transmission.

IN "The Space-time Manifold of Relativity" (Proc. American Acad. of Arts and Sc., vol. xlviii., No. 11, 1912), Profs. E. B. Wilson and G. N. Lewis give a full and very interesting account of their attempts to construct systematically a peculiar kind of non-Euclidean geometry suitable for the representation of the fundamental parts of the modern theory of relativity, along with its applications to mechanics and electromagnetism. Their scheme is in its essential idea similar to Sommerfeld's four-dimensional vector-algebra and analysis (*Annalen d. Physik*, vol. xxxii.-xxxiii., 1910), but is more radically vectorial, introducing, instead of a mere juxtaposition of four scalars, a formal sum of four vectors corresponding to as many mutually perpendicular unit vectors, with six "2-vectors" and four "3-vectors" to match. Another chief characteristic is that, while Sommerfeld has developed a vector algebra and analysis of essentially Euclidean four-dimensional space, Wilson and Lewis give us from the outset a non-Euclidean system, which suits better the requirements of relativity. Especially interesting as regards novelty of ideas is a discussion, given as a preliminary to "Electromagnetics and Mechanics" (art. 45-47), of the possibility of replacing conceptually continuous and discontinuous distributions by one another, and of a case in which such a substitution is impossible. To make the whole system more accessible to a wide circle of non-specialists, the authors proceed by developing their new geometry first in two, then in three, and, finally, in four dimensions. Another feature of the paper is an uncommon brilliancy of exposition. With but one caution regarding a certain statement about the "extended momentum" (p. 479), which possibly is erroneous, we can recommend the paper warmly, both to freshmen in relativity and to specialists.

The Clarendon Press has published a translation by Mr. A. S. L. Farquharson of Aristotle's "De Motu Animalium de Incessu Animalium," at the price of 2s. net. This booklet completes the fifth volume of the English translation of the works of Aristotle which is being issued under the editorship of Messrs. J. A. Smith and W. D. Ross. It was the desire of the late Dr. Jowett, as formulated by his will, that the proceeds from the sale of his works, the copyright in which he bequeathed to Balliol College, should be used to promote the study of Greek literature. In a codicil to his will he expressed the hope that the translation of Aristotle's works begun by his own translation of the "Politics" should be proceeded with. The volumes to which the present part is a contribution represent the result of the cooperation of Balliol College and the delegates of the Clarendon Press to carry out Jowett's wishes.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences for February:—

Feb. 2. 8h. 43m. Jupiter in conjunction with the Moon (Jupiter 5° 17′ N.).
3. 6h. 38m. Mars in conjunction with the Moon (Mars 4° 13′ N.).
4. 13h. 56m. Uranus in conjunction with the Moon (Uranus 4° 1′ N.).
5. 4h. 14m. Mercury in conjunction with the Moon (Mercury 2° 9′ N.).
10. 0h. 13m. Venus in conjunction with the Moon (Venus 0° 51′ N.).
12. 2h. 0m. Venus at greatest elongation E. of the Sun.
,, 11h. 0m. Mercury in superior conjunction with the Sun.
14. 3h. 33m. Saturn in conjunction with the Moon (Saturn 6° 20′ S.).
Feb. 16. 0h. 0m. Saturn at quadrature to the Sun.
18. 0h. 11m. Neptune in conjunction with the Moon (Neptune 5° 30′ S.).
25. 16h. 44m. Mars in conjunction with Uranus (Mars 0° 26′ S.).

The Reported Bright Meteor of December 18.—From notes published by Mr. J. H. Elgie in *The Yorkshire Weekly Post* we learn that the bright object, mentioned in these columns on January 2 as having been seen near Manchester on December 18, was also seen by several observers in Yorkshire. Mr. Platts describes it as being spherical, the diameter being about half that of the moon, and as leaving a bluish trail. After travelling some distance the meteor divided into two portions, the smaller appearing to fall earthwards, while the larger continued in the original path; other observers describe the object as being of exceptional brilliance. Several further letters appeared in the Manchester *Daily Dispatch*, but contain no more precise data than that already given here. Mr. Elgie suggests an atmospheric, rather than a cosmic, origin, and the more precise details necessary to determine the true nature and path of this object would be of scientific interest and value.

Catalogue of Celestial Objects.—We have received the second part of M. G. Raymond's catalogue, "Les Merveilles du Monde Sidéral" (Paris: G. Thomas), which gives brief descriptions, positions, &c., for all peculiar objects between vih. and xiih. right-ascension. This catalogue will be found extremely useful by amateur observers, the objects being arranged in right-ascension, and a brief description given for each; thus one constellation may appear in several different sections, but the different units may be successively examined in the order given. A large number of the descriptions are those of the author himself, others are quoted from different authorities, and in regard to those for double and coloured stars it is possible that some of the hues given are subjective, due to contrast, retinal fatigue, and "dazzle tints," as suggested by Prof. Louis Bell.

The Vagaries of Encke's Comet.—An interesting article discussing the peculiar variation of the period of Encke's comet is contributed by Mr. E. V. Heward to the December number of *The Oxford and Cambridge Review*. Mr. Heward recounts the results obtained from the various calculations of Encke which led him to the idea of a resisting medium in interplanetary space, and briefly discusses the arguments for and against the existence of such a medium. Until the 1867-71 return the acceleration of the comet's motion was fairly constant, but it then suddenly diminished by nearly one-half, only to return to its earlier value at subsequent revolutions. Mr. Heward points out that the theory promulgated by Dr. Backlund, viz. that the comet encountered a stream of meteors of varying density when near perihelion, satisfactorily explains the vagaries of period and is not a negation of the resisting medium idea.

Relative Proper Motions of 162 Stars near the Orion Nebula.—While spending the year 1911-12 at the Yerkes Observatory Dr. A. van Maanen measured a number of plates of the neighbourhood surrounding the Orion nebula, which were taken on different dates between 1901 and 1912, with the 40-in. refractor. The results show the advantage of using a long-focus instrument, the mean probable errors of the final proper motions being only 0·0060″ in α and 0·0047″ in δ. One hundred and sixty-two stars were discussed, and the proper motions are nearly all very small, only three exceeding 0·100″ per annum. (*Astronomical Journal*, No. 642.)

THE AVIATION EXHIBITS AT THE SCIENCE MUSEUM, SOUTH KENSINGTON.[1]

THE aviation exhibition which is open until the end of February at the Science Museum, South Kensington, illustrates, in many cases by means of actual flying machines, the more important scientific principles underlying the practice of flying. Aviation is a new art, and it comes almost as a shock to a visitor to the exhibition to find that so long ago as 1844–5 a model of a flying machine was made by Henson, which, from the illustrations (Figs. 1 and 2) will be seen to bear a striking resemblance to recent monoplanes. For a moment at least a doubt arises as to the assumed progress of the science in recent years, especially when it is realised that one of the greatest difficulties confronting Henson and his co-pioneer, Stringfellow, was the provision of a powerful and sufficiently light engine. The doubt as to our present progress is removed on further inquiry, although we can quite realise that the science of aërodynamics has, for at least half a century, waited for the development of the light petrol engine.

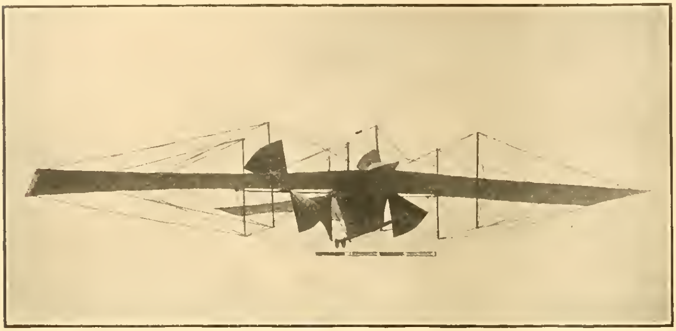

FIG. 1.—Henson's proposed flying machine, 1844–5.

Such differences as occur between Henson's proposed machine and those of the present day are essentially those which have been introduced since aëroplanes lifted themselves from the ground and aviators found themselves under the necessity of balancing their machines in more directions than for any previously known form of locomotion.

The quantitative side of the science of aviation received its beginning and a powerful initial impulse from the work of Langley. As a result of his experiments prior to 1896, Langley calculated the size of wings necessary to carry a small steam engine, and made models which flew for considerable distances. Lilienthal afterwards introduced a universally accepted modification into the shape of the wings by giving a camber to the section, but the calculation of the size of the wings necessary to support a given weight at a specified speed still rests substantially on the same data as were obtained by Langley.

Besides having the proportions of a good lifting surface, the Henson model is further interesting in that it has a body carefully shaped so as to offer a small air resistance, a point of design now receiving much attention. Such a surface, unless carefully placed, might, however, make the machine liable to rolling instability, a point of difficulty which remained for nearly two years after power-driven aëroplanes capable of carrying an aviator had left the ground. The method of control introduced by the Wright brothers, and shown in the exhibition by the actual working of the mechanism of a "Baby" Wright biplane and a skeletonised Wilbur Wright control, made flying for longer periods than a few minutes a regular performance, and has now been universally adopted. Before this stage of progress had been reached, Lilienthal and Pilcher, whose machines are exhibited, lost their lives in an attempt to obtain stability by the motion relative to the wing surfaces of a considerable mass.

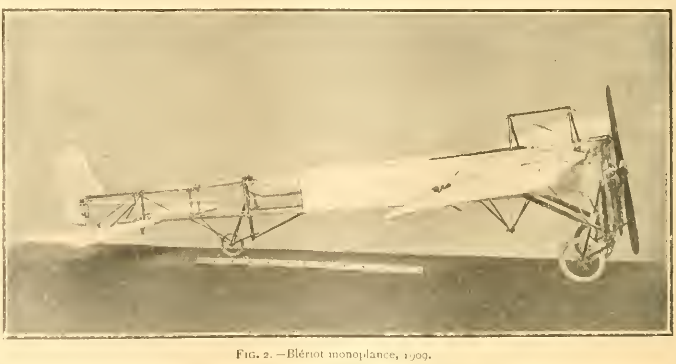

FIG. 2.—Blériot monoplane, 1909.

Their experiments were carried out on gliders, *i.e.* machines which obtained the necessary energy for motion from a descent under the action of gravity, and the aviator's body was the mass moved. This method of control has been entirely superseded by the invention of the Wright brothers.

How far the modern aëroplane is able to look after its own safety and how far it is dependent on the skill of its pilot is still a subject for investigation. The tendency appears to be to try to obtain stability

[1] The illustrations which accompany this article are from the Catalogue of the Exhibits, and are reproduced with permission of the Controller of H.M. Stationery Office.

by means of rigid surfaces, the stability asked for being somewhat similar to that of a Canadian canoe, which allows rolling up to a certain inclination for very small movements of the occupant, but offers great resistance to any motion beyond that limit. Such stability, if realisable, would leave the aëroplane sensitive to the pilot's control except in cases of emergency, when the aëroplane had departed considerably from its position of equilibrium, when it would assist the pilot to regain control. If, alternatively, it should ultimately be decided that the pilot must be assisted automatically, then some such device as the Clarke Johnson gyroscopic control exhibited might be used.

SCIENCE AT RECENT EDUCATIONAL CONFERENCES.

IN a previous article (January 23) reference was made to the teaching of physiology and hygiene in schools. At the London County Council Conference of Teachers a considerable portion of the programme was concerned, directly or indirectly, with these subjects. Prof. Starling presided at the fourth session, and referred to the training in physiology of the teacher and the training in physiology or hygiene of the child. It was sufficient if the child was brought up with the knowledge of the rules of right living, but these rules were founded on physiology, and the teacher must have reason for the faith that was in him. On that ground the Physiological Society had appealed to the Board of Education to provide additional facilities for the study of physiology by teachers, and to make such study compulsory.

At the same meeting Prof. Leonard Hill gave an address on open-air and exercise, Mrs. Truelove read a paper on instruction in infant care in girls' schools, and Mr. A. J. Green discussed the value of the open-air school. It is further to be noted that, at each of the three preceding sessions of this conference, subjects bearing closely on the health of the children were brought forward, and the medical profession figured prominently in the discussions. As we are all aware, the tendency to pay regard to the physical welfare of school children is prominent in the programmes of other educational meetings—*e.g.* British Association, Section L. Why this exceptional solicitude at the present time?

It may be granted that administrative and political factors have given much strength to this movement, but there are perhaps somewhat deeper reasons for the ready response of teachers to the call now made upon them to regard their work as one of the agents in determining the health of the nation in years to come. One of these deeper reasons is that biology, with her handmaiden evolution, is come into her own. The child is viewed as an organism; teachers and administrators are thinking biologically. The old platform tag, *mens sana in corpore sano*, implied a duality of mind and body, whereas to-day we recognise that the *mens* and *corpus* are educationally inseparable. The psychology of McDougall and the newer school is the offspring of a union of the old psychology with biology—it is not a mere change of the old, but a new-born science. And of this new source of inspiration teachers are drinking in increasing numbers.

The papers of the third session of the L.C.C. Conference were devoted entirely to an exposition of the modern teachings of psychology on the subject of attention. Prof. Spearman, who presided, stated the relations between psychology and education as those of "equal allies who had a joint mission—perhaps the greatest national mission—the making of the nation itself." The words just quoted give the clue to the other great influence which, side by side with psychology—the thinking biologically of the individual—is now influencing the trend of educational ideals and progress. This second influence is to be found in the growing sense of social and economic interdependence—the thinking biologically of communities—the viewing of the State as an organism, and even of world-commerce as an organism. Hence the feeling that an education lacks an important essential which neglects that promising avenue of human progress—the study of economics. There also flows from this sense of social solidarity an increased sense of responsibility for the economic conditions affecting the lives of the poorer classes.

These trends of thought and feeling found respective expression in the educational conferences in the discussions on economics for schoolboys at the L.C.C. Conference, when secondary education was being discussed, and in those on household economics of the poor, at the meeting of Teachers of Domestic Subjects. At this meeting Mr. J. Wilson proposed to weave the two threads of State and domestic economics when he suggested that, in the allocation of the State Development grants, the claims of investigation into possible improvements of methods or appliances used in household work should receive consideration.

That thousands of teachers assembled during their Christmas holidays in twenty conferences in order to "talk shop" shows to every thoughtful person that the teaching profession is spiritually sound. This article fails if it does not indicate, however imperfectly, that the profession is studying its calling with the methods of science, and is no longer satisfied with empiricism. The growth of a body of educational workers thus animated with scientific purpose is the best warrant, if not of the present existence, at least of the imminent development, of a science of education.

G. F. DANIELL.

MODERN MICROSCOPICAL OPTICS WITH SPECIAL REFERENCE TO FLUORITE OBJECTIVES.

GAUSS'S theory of lenses and other optical systems, which was published in 1840 in his "Dioptrische Untersuchungen," and subsequently largely extended by many other investigators, rendered it possible to apply the cardinal theorems relating to the formation of optical images to the most complicated systems of lenses, of which already in Gauss's time the microscope objectives furnished a good example. This theory paved the way for the computation of microscopic objectives and furnished a means of studying the optical principles of the microscope as a whole and the objective and eyepiece considered separately.

Even before Gauss, Fraunhofer in 1820 had succeeded in devising a complete system, enabling him to compute telescope lenses, and a little later Seidel and Steinheil evolved a similarly complete system for the computation of photographic lenses.

Prof. E. Abbe, who in 1866 became associated with the optical establishment of Carl Zeiss in Jena, was the first to venture upon a complete calculation of the microscope objective by applying the theory of Gauss. After a series of futile attempts, he established a system by which a microscope objective could be computed in every detail. The methods by which he applied his system to practical computations have not been made known.

A further valuable contribution to practical optics was made by Helmholtz and Abbe, who, by discovering the sine condition, showed the means by which an object and its image can be made geometrically similar. It is, however, a great mistake to suppose that these achievements in the mathematical equipment of the microscope inaugurated a brilliant epoch in the history of the microscope, and that enormous progress was made henceforth. In the first place, it was found that by a carefully developed trial-and-error system opticians had succeeded in producing objectives which in a high degree satisfied the conditions postulated by mathematical theory. Thus it was found that all objectives tested by Abbe completely satisfied the sine condition, although until then this had been unknown in principle.

The investigations of Helmholtz and Abbe (1873–4) showed by the formula of the former, $\epsilon = \frac{\lambda}{2 \sin \alpha}$, and Abbe's formula, $\epsilon = \frac{\lambda}{2n \sin \alpha}$, that the optical performance of the microscope is confined within definite limits. In these formulæ ϵ denotes the smallest distance separating two successive particles of an object which can be differentiated under a microscope; λ is the wave length of any given ray of light, as defined by Helmholtz, in air or any other medium intervening between the object and the front lens; α is the semi-apertural angle of the objective, and n the refractive index of the medium between the objective and the cover glass. In dry lenses the value of n is accordingly 1·0, in water-immersion it is 1·33, and in oil-immersion lenses $n = 1{\cdot}52$. The denominator in Abbe's formula, $n \sin \alpha$, has been named by him the numerical aperture of the lens; it furnishes the principal criterion of the optical capacity of the microscope. When these factors, which determine the optical resources of the microscope, were discovered, the microscope had already been brought to a very high degree of perfection by purely empirical means, and in practical respects the formula had already been satisfied to a very considerable extent, and but little scope was left to the investigator and computor. The apertural angle had already attained very considerable magnitudes; water-immersion and oil-immersion lenses were already in existence, and accordingly the element n in Abbe's formula had already received practical consideration, whilst in the formula enunciated by Helmholtz the wave length of a ray in air had become reduced to a quotient $\frac{\lambda}{n}$, by which the wave length was shortened in proportion to the refractive index of the medium.

Amici in Italy, Spencer in America, Fraunhofer, Kellner, Oberhäuser, and Hartnack in Germany, Chevalier in France, and Ross and Powell and Lealand in England had all done a great deal to perfect the microscope objective. In medical research a new era had been inaugurated by the achievements of microscopic observations; histology and pathology had been placed upon a firm basis; and Pasteur had already planted the beginnings of bacteriology and identified a number of pathogenic germs. In the face of the difficulties and limited possibilities with which the optician had to contend, it would be interesting to form an estimate of the results which opticians had been able to achieve from the time that they commenced to apply the resources of scientific research. The formula given above made it clear that there was no possibility of extending the capacity of the microscope by increasing without limit its magnifying power. Means had indeed been found to increase the angular aperture α in a measure as the magnification rose higher and higher, but there was a limit beyond which it was impossible to increase the magnifying power of a lens without reducing the free distance between the object and the front lens to an impracticably small amount, which did not even provide room for a thin cover glass. Continued attempts were made to extend the power of the microscope by increasing its magnifying power. It was soon found that lenses having such extremely short focal lengths as 1/20 in. 1/50 in., and even 1/75 in., in which there was no corresponding increase of the angle of aperture, were in no wise superior in their optical capacity to lenses of lower power, and the trouble expended upon them was clearly wasted. These extremely high powers, of which many examples were produced by the opticians of fifty or forty years ago, have now been entirely discarded, and one rarely meets now objectives having a shorter focus than 1/16 in.

Opticians then proceeded to concentrate their efforts upon increasing the numerical aperture. Dry lenses had already then been made with apertures of 0·90, and this value has not been exceeded even in these days. Water-immersion and oil-immersion lenses, with their theoretical apertural limits of 1·32 and 1·52, were, however, still far removed from what was practically attainable; in fact, they did not exceed 1·0 in water-immersion and 1·2 in oil-immersion lenses. To carry the aperture further it was necessary to endow the lenses with a greatly improved spherical correction, and much higher demands were made upon the skill of the optician, both in the matter of lens grinding and mounting. By the exercise of an extraordinary degree of skill in the mounting of the front lenses and by clamping them by their extreme ridge, the practical optician has come very near to the theoretical limits, and has been able to realise apertures up to 1·2 in water-immersion lenses and 1·4 in oil-immersion lenses. These were momentous achievements, and it is to lenses of high aperture that bacteriological research owes the greater part of its success. When the limit had been thus reached in both types it was thought to increase the power of the lens by introducing a medium of higher refractive power. Since the transition of light from air ($n = 1$) to water ($n = 1{\cdot}33$), and that from air to oil ($n = 1{\cdot}52$) had furnished such striking results, it was expected that the transition to a more highly refracting medium having a refractive index of 1·66 would furnish a means of increasing the aperture still further.

An objective of this kind, in which the immersion medium was monobrome naphthalin, was computed by Prof. Abbe and made by Carl Zeiss in 1889. Its numerical aperture was 1·60. To secure the full advantage of this large aperture it became, however, necessary to satisfy an extensive range of conditions. The condenser must have a similar aperture, both it and object slide required to be joined by a stratum of monobrome naphthalin, and the slide as well as the cover glass had to be made of glass having the same refractive index as the immersion medium, and the object itself had to be mounted in a powerfully refracting medium.

Dr. Van Heurck (Van Heurck, "Le Microscope," 1891, p. 63), who used this objective for a considerable time, and obtained with it many remarkable photographs, including striking photographs of *Amphipleura pellucida*, whilst praising the great resolving power of the objective, described it as scarcely adapted for regular practical use, both on account of the enormous difficulties which its use entails and its inordinately high price. Of the chief causes which militate against the use of the objective, and indeed render it almost impracticable, Czapski remarks in the *Zeitschrift fur wissensch. Mikroskopie*, vol. viii., 1891, p. 149, as follows:—Organic preparations require from their very nature to be embedded in media which in the majority of cases have a much lower refractive index than the immersion fluid for which the objective has been computed. This excludes all these preparations from observation with the monobrome naphthalin lens, since one of the principal conditions for the successful use of the lens remains unfulfilled. Even the difficulties which attend the use of the objective and its high price could never have been regarded as a sufficient reason for dispensing with its services if any considerable range of objects existed which could bear being embedded in the media having the requisite optical properties, and in which the capacity of the lens could be turned to full account. As it is, the objective is only known by the photographs taken by Van Heurck, and, as a matter of fact, the lens has long ceased to be manufactured.

There is yet another way of enhancing the working capacity of a lens, as will be seen from the formulæ of Helmholtz. The wave length of light may be reduced by working with white light having a wave length of 0·00055 mm., or blue light having a wave length of 0·00043 mm., or ultra-violet light having a wave length of 0·00028 mm. Blue light reduces by about 1/4–1/5 of its original value, whilst ultra-violet light reduces it to about one-half. A few years ago Dr. A. Koehler investigated successfully what might be accomplished in this direction by the use of light of extremely short wave lengths (*Zeitschr. f. wiss. Mikr.*, vol xxi., 1904, p. 129 *et seq.*). An elaborate new apparatus was required to obtain tangible results from the application of very short waves. Even the best glasses that will transmit ultra-violet light did not suffice for the purposes of this investigation, and the only materials which transmitted ultra-violet light of sufficient intensity were fused quartz and fluorspar. The condenser, the object slide, cover glass, objectives, and eyepieces had all to be made from either of these materials, whilst glycerin served as the immersion fluid. Only a limited number of mounting media were available for use with this apparatus. The lacking intensity of this light rendered it impossible to apply it visionally, and recourse was accordingly had to the photographic method. The difficulties encountered in focussing the object have been overcome by the application of fluorescent light.

The greatest difficulties were encountered in the construction of the objectives. Owing to the limited choice of materials it was impossible to attempt to make the lens achromatic, and indeed this was scarcely a matter of importance, seeing that the light used is almost monochromatic. On the other hand, the use of simple lenses made it impossible to secure spherical correction with respect to more than a small central aperture. This applies at least to a high power dry lens and to an oil-immersion lens of lower power.

There is another circumstance which was found to be a serious drawback, in that the lenses of the objectives had necessarily to be mounted without the usual adjustments by means of which departures in the radii, thickness, distance between the lenses, and irregularities in the homogeneity of the glasses may be allowed for, since it is almost beyond the resources of a workshop to apply any direct test to lenses corrected with respect to the ultra-violet light. It will be readily appreciated that an objective which is made exclusively on the strength of data obtained by calculation without the controlling aid of the optician's art must necessarily be of the nature of chance products. In these circumstances one may either dispense with the highest degree of perfection by accepting an objective as it leaves the optician's hands, or one may from one of a series of several lenses select the one which is best, by direct observation with a fluorescent screen, with a fluorescent eyepiece, or by photographic tests, but such a proceeding would be inordinately costly. Koehler's investigations have the merit of having clearly demonstrated the almost insuperable difficulties with which one has to contend when attempting to apply ultra-violet light. The photographs which have been obtained so far with the aid of ultra-violet light have scarcely furnished any new aspect of the structure of microscopic objects.

Apochromatic and Fluorite Lenses.

The labours of Abbe and Schott in the study and production of optical glasses, which were begun in 1881, were to a certain extent completed in 1886. In the technical laboratory established by them under the title of Schott und Genossen, they brought out, in addition to the crown and flint glasses then in use, an extensive series of glasses having markedly improved optical properties and of a different chemical composition. By introducing phosphoric acid and boric acid as components of glass smeltings, in addition to silicic acid, they succeeded in producing new crown and flint glasses, the so-called phosphate and borate glasses, in which the rate of change of the dispersion is remarkably proportional, so that it appeared possible by the combination of these glasses partly to eliminate the secondary spectrum, which hitherto it had been impossible to eliminate to any appreciable extent. In the course of time the Schott works introduced an extensive selection of optical glasses, which greatly simplified the computing optician's work. The list includes glasses of similar refringent properties but widely different dispersion, and others again having a similar dispersion but covering a wide range of refractive indices. This was a great advance over the old glasses, in which any increase of dispersion was attended with a rise in the refractive power.

A valuable feature of the new glasses is that the glass works were able to reproduce very closely any of the types specified in their catalogues, and, in addition, every new pot was examined with the spectrometer and its constants recorded. This relieves the computer of the task of having to determine for himself the optical properties of the glasses, and likewise the optician working on the trial-and-error principle was enabled more easily to attain his purpose by a judicious variation of the glasses in accordance with their refractive properties and dispersions. These glasses were used for the first time in apochromatic objectives as originated by Zeiss. This would indeed have been a stupendous achievement if, as the makers of these lenses maintained at first, their success had been solely due to the use of the new phosphate and borate glasses. Unfortunately, as we shall have occasion to show, it was the introduction of fluorite into the composition of the lenses which was responsible for these achievements.

The new objectives, which were completed in 1886, proved a great advertisement for the glass works of Messrs. Schott und Genossen. Of the use of fluorite, however, not a word was uttered, even in a lecture delivered by Abbe on the subject before a scientific gathering and published in the Transactions of the *Jenaische Gesellschaft für Medizin und Naturwissenschaften*, under the title, "Ueber neue Mikroskope," or, as it appeared in a subsequent reprint, "Ueber Verbesserung des Mikroskops mit Hilfe neuer

Arten optischer Gläser." Again, not a word was said of fluorite in a paper entitled, "On Improvements of the Microscope with the Aid of New Kinds of Optical Glass," which appeared in the Journal of the Royal Microscopical Society, vi., 1886, p. 20, *et seq.*; neither was it mentioned in a publication prepared for French readers, and entitled, "Nouveaux Objectifs et Oculaires pour Microscopes construits avec les verres spéciaux de la Verrerie scientifique (Schott et Cie.), par Carl Zeiss, Atelier d'Optique à Jena."

Four years passed before the true facts of the case were made known by the firm of Zeiss in an article published in the *Zeitschrift für Instrumentenkunde*, 1890, p. 1, under the heading, "Ueber die Verwendung des Fluorits für optische Zwecke." Long before the publication of this paper other firms, having failed to produce lenses equivalent to the apochromatic lenses with the aid of the new glasses only, had realised that the great advances in achromatic correction embodied in the apochromatic lenses were not due in the first instance to the use of the new glasses but rather to that of fluorite. Doubtless Abbe had set himself the task of achieving chromatic correction of a higher order by means of the new glasses only, but he failed in accomplishing any very striking results with the aid of these glasses only, and, moreover, the optically most trustworthy glasses could be used in a very restricted sense only, owing to their lack of resistance to atmospheric influences.

We will now briefly discuss the conditions under which glasses combined to form crown and flint glass pairs will furnish a means of securing a more or less complete degree of spherical and chromatic correction.

The older lenses of the achromatic type are composed of two doublet lenses for the lower and moderately high powers, with one or two front lenses of crown glass added for the high powers. The doublet lens consists of a negative flint glass component and a positive crown glass component cemented thereto. The spherical correction is in the main effected at the surface of contact between the components of the doublets. The magnitude of the difference in the refractive indices of the flint and crown glass components governs the curvature of the cemented surfaces, and it should be as high as possible to flatten the surface and to adduce favourable conditions for the correction of the spherical aberration and for securing a high aperture. To eliminate the chromatic aberration the glasses are so chosen that the dispersion of the highly refracting flint may be considerably greater than that of the less refringent crown glass. A good gauge of the dispersive properties of a glass is furnished by the formula $\frac{nD-1}{nF-nC}=\nu$: nF, nD, nC denote the refractive indices with respect to the rays corresponding to the F, D, and C lines of the spectrum; $nF-nC$ stands for the mean dispersion; $\frac{nF-nC}{nD-1}$ supplies an expression for the dispersive power, whilst its reciprocal value, usually denoted by the letter ν, is known as the efficiency of the optical medium.

In the list of glasses made by Messrs. Schott and Co. the glasses are arranged in a progressive order of ascending values of the efficiency ν. Glasses in which the value of ν ranges from 75 to 55 are usually classed as crown glasses, whilst those in which ν has a smaller value go by the name of flint glasses. The combination of a positive crown glass lens with a negative flint glass lens affords a means of correcting the chromatic aberration.

A higher degree of achromatisation can be attained, *i.e.* the secondary spectrum may be eliminated and rays made to meet in a point with respect to more than two colours, if glasses are chosen in which the dispersions proceed by proportional steps. The degree to which this requirement is satisfied may be ascertained by dividing the difference of the refractive indices for two fixed lines of the spectrum, say F and G′, *i.e.* the so-called partial dispersion, by the difference of the refractive indices for the interval C to F. the so-called mean dispersion. A pair of crown and flint glasses, in which the quotients $\frac{nG'-nF}{nF-nC}$ differ least will be best adapted for the achromatisation of an optical combination with respect to a third colour.

	nD	ν	q	Δq
Achromatic Lenses.				
Crown 0·60 ..	1·5179	60·2	0·566	43–49
Flint No. 36–38 ...	1·6202–1·6489	36·2–33·8	0·609–0·615	
Pantachromatic Lenses.				
Phosphate crown 1.	1·5159	70·0	0.552	
Borate flint	1·5521	53·8	0·567	15–31
" " ..	1·6086	44·3	0·583	
Apochromatic Lenses.				
Fluorite	1·4338	95·4	0·561	
Boro silicate crown.	1·5100	64·0	0·559	
Barium-silicate crown	1·5399	59·4	0·566	2 10
Dense barium-silicate crown	1·5726	57·5	0 571	

The above table shows in the first section a pair of glasses such as are used to produce an achromatic lens, and it will be seen to what extent the refractive indices of the components nD and the values of ν should differ to effect the requisite spherical and chromatic corrections. It will be seen that the quotients given in the column headed q, viz. $\frac{\text{partial dispersion}}{\text{mean dispersion}}$, differ by an amount $\Delta q = 43$ to 49 units. With this difference remaining there is still a pronounced secondary spectrum, since the imperfect proportionality in the configuration of the spectra due to the glasses renders it impossible to bring three colours to a point.

The second section typifies the new glasses which were employed to effect a higher degree of correction in achromatic lenses. In the first place, the difference in the refringent properties of the phosphate crowns and borate flints was not sufficient to obtain such flat lens curvatures as are needed to ensure a large aperture, at least not with a single pair of glasses. The quotiental difference, Δq, is in these glasses brought down to 15–31. This signifies already a very marked advance, and to improve still further upon it one would have to have recourse to denser flint glasses of greater refractive power so as to obtain better conditions for correcting the spherical aberration by flattening the curvative. Even if it had proved possible, by complicating the formula, to evade the presence of pronounced curvatures and to use glasses of a small quotiental difference only, there would still have remained an insurmountable difficulty in that all borate and phosphate glasses are so little permanent as to exclude their use in lenses. An objective containing elements made up of these materials, whilst produced at a greatly increased cost, could not have failed to become useless in a very short time. Those lens-makers who used these glasses before they had had time to realise their peculiarities had to pay dearly for their subsequent experience.

The third section of the table comprises fluorite and a number of glasses with which it may be associated to form achromatic pairs. The difference in the refractive properties of fluorite and these glasses is not less than in the ordinary glasses, such as enter into the composition of the well-proved older achromatic lenses, and it is sufficiently great to insure the flat curvatures needed for spherical correction. The difference in dispersion is at least equal to that occurring in the achromatic lenses, and hence no obstacles are encountered in bringing two colours to a point. The significant result derived from the use of fluorite is that the difference of the quotients q reduces to 2–10 units, and almost disappears even in some combinations, so that in addition to rays corresponding to the D and F lines of the spectrum a ray of yet another colour, corresponding to G′, can be brought to a point. The immense utility of fluorite lies in the fact of its low refractive index being coupled with an extraordinary small dispersion, by which it differs in a striking degree from the glasses, whilst yet the quotient is similar to that of the existing crown glasses. The use of fluorite in the place of the usual crown glass component rendered it possible to replace the ordinary flint component with its disproportional dispersion by a crown glass having either a quotient agreeing with that of fluorite or at least differing but slightly from it.

The older silicate crown glasses, which had so far been used in the composition of achromatic lenses, contain a number of glasses which differ widely from one another in their refractive and dispersional properties, whilst their quotient is much the same as that of fluorite. By combining fluorite with these crown glasses a means was obtained of producing more perfectly achromatic lenses without the need of a new glass.

It will thus be seen that the new glasses were quite a subordinate element in the composition of apochromatic lenses. There is no doubt that their greater range of variety has made it easier to produce apochromatic lenses, but it is not essentially owing to them that apochromatic lenses have come into existence. In 1891 Leitz made an attempt to produce lenses of a higher degree of correction by the use of glasses only. These were the so-called pantachromatic lenses, the optical qualities of which were intermediate between those of the achromatic and apochromatic lenses. The attempt, however, had soon to be discontinued since those glasses which had proved the best means of endowing the pantachromatic lenses with a higher degree of colour correction proved to be liable to deterioration. Within the last ten years several opticians have introduced a new class of objectives, the so-called fluorite lenses, in which the qualities of the former pantachromatic lenses are realised with the aid of fluorite.

These objectives have, so far as the author is aware, the simple composition of the achromatic lenses, and do away with the necessity of introducing a triple lens, which renders them much less costly than the apochromatic lenses. In their degree of colour correction they approximate to apochromatic lenses in proportion to the number of fluorite lenses used in the system. Dispensing, however, with the triple lens, they cannot be rendered equivalent to apochromatic lenses, even when the number of fluorite lenses is the same in both systems. On the other hand, it is the presence of the triple lens which adds materially to the cost of the apochromatic lenses.

Reviewing the results achieved within the many years during which the practical optician has been guided and aided by the resources of science, it cannot be said that any epoch-making progress has been made. Yet it cannot be denied that modern men of science and practical opticians have manifested an extraordinary activity in their keen desire to improve the power of the microscope and to extend our knowledge of the instrument.

Comparing the performance of modern lenses with those of thirty years ago one cannot fail to realise that steady progress has been made. An objective of numerical aperture 1·40 is a remarkable piece of work, and there is scarcely a modern lens that does not bear testimony to the fruitfulness of recent efforts. New types of objectives have likewise been devised for the needs of the photographer, and various new devices for observation by dark-ground illumination, especially Leitz's dark-ground condenser, have developed this method of observation in a surprising manner. The indefatigable activity of opticians as well as physicists has elucidated the nature of the problems relating to the limits within which it is possible to improve the microscope, and has given us a better insight into the *modus operandi* of the instrument. It may suffice to remind the reader of Abbe's theory of optical instruments.

To what extent the study of microscopic optics has occupied the minds of research workers is eloquently borne out by the vast literature which during this period deals with the microscope. Of journals devoted to the study of the microscope we may mention the *Zeitschrift für wissenschaftliche Mikroskopie*, the Journal of the Royal Microscopical Society, and the Journal of the Quekett Microscopical Club. The microscope forms also the subject of extensive works, amongst which one may mention those of Abbe, Dippel, Lummer and Reiche, van Heurck, Wright, Spitta, and Carpenter. A number of meritorious works have been published which, whilst dealing with optical matters in general, go far to further the development of microscopical optics. Of the authors who have written on geometrical optics and optical instruments we may mention Ferraris, Herman, Maxwell, Lord Rayleigh, Heath, Gleichen, Drude, Czapski, von Rohr, Whittaker, Gullstrand, Leathem, Schwarzschild, Maclaurin.

It has often been said that the microscope has reached the limits of its resources. Certain it is that it has needed the application of the utmost skill and the most strenuous efforts to enhance the powers of the microscope during recent years. There is, however, every prospect that the ever-extending use of the instrument, the increasing demands made upon it, the intense scientific attention bestowed upon its development, and the fine training of the modern optician will not fail to maintain progress.

C. METZ.

SOME OF THE NEXT STEPS IN BOTANICAL SCIENCE.[1]

WHEN one who has worked long in any field of science speaks before an audience such as this he is expected to say something about the condition of his branch of science when he began work with meagre and poorly adapted apparatus, to contrast it with its greatly improved condition to-day, and to dwell with pride upon the finely equipped laboratories with costly apparatus, especially designed for particular experiments, to be found by the twentieth-century scientific student.

In order that we may properly orient ourselves with reference to the area covered by the science of botany to-day, we shall have to go back a few decades to understand what additions have been made to its territory during this period of expansion.

Consider for a few minutes the botany of forty years

[1] From an address delivered before the American Association for the Advancement of Science at Cleveland, Ohio, December, 1912, by the retiring president, Prof. C. E. Bessey.

ago, when one could count on the fingers of one hand the American colleges that had chairs of botany. And here I use the term chair advisedly, for they were literally chairs and not departments, much less laboratories. And everywhere else in the colleges of the country the chairs of botany were represented by what Holmes so aptly called "settees," from the number of subjects taught therefrom. The botany dispensed from these chairs was the delightful study of the external morphology of the higher plants, especial emphasis being laid upon the structure of flowers and fruits.

And with this external morphology there was always associated the classification of the higher plants, in its simpler form the pleasurable pastime of identifying the plants of the neighbourhood, and in its more advanced form represented by the work of Torrey and Gray, and Vasey and Engelmann. We should judge systematic botany of that day by the work of these masters, and not by the diversions of its amateurs; and you will agree with me that, so judged, the systematic botany of that period will not fall short of any standard we have set up in these later days.

The botany of that day was not without its laborious investigations and its tangible results. That was the day of the founding of many small botanical gardens, and small local herbaria, some of which, having served their purpose, disappeared long since, while others have grown into the great and flourishing institutions of to-day.

And what of the botany of to-day? The *personnel* of botany has greatly increased with the great increase in the territory it now includes. This *personnel*, it must be said, is still quite heterogeneous. Some of us are largely self-taught, so far as the major part of the subject is concerned. We brought to our work the results of the meagre teaching of the old-time college class-rooms, and year by year we have enlarged the borders of our own departments as we have added to our own knowledge of the subject by means of our laboratories and libraries. Thus we have built all kinds of superstructures upon the foundations supplied by our teachers. As a consequence the science is yet largely unorganised and lacks consistency in plan and purpose.

This difference of opinion as to what constitutes botany results in the absence of united effort. In its simplest aspect it takes the familiar form of uncertainty as to the content and value of the work done by the student elsewhere when he transfers himself from one college to another. As a matter of fact, there is yet no agreement as to what is a standard first-year's course in college botany. What teacher has not been sorely puzzled to know to what courses to admit men who came from another college with credits in botany! Ignorance is no valid excuse for the scientific man, and in science everything is worth while. It is to our shame as botanists that we acknowledge our inability hitherto to frame a standard first-year course in college botany. When the science is definitely formulated in the minds of botanists the present disagreement will no longer exist. Surely we now "see as through a glass darkly."

Again, it may be remarked that we are to-day placing great emphasis upon the applications of botany to some of the great human activities, especially to agriculture. Witness the agricultural experiment stations with their botanists of all kinds, from those who study weeds and poisonous plants, to the physiologists, pathologists, ecologists, and plant-breeders. And as we look over the work they do we are filled with admiration and pride that they have individually done so well. But it is not the cumulative work of an army of science; it is rather the disconnected, unrelated work of so many individuals. They are doing scientific work in an unscientific way. Botanical science which should have guided and directed these laudable applications has not kept pace with them, and we have the spectacle of these economic botanists, physiologists, pathologists, plant-breeders, and others working apart from the botanists proper, and sometimes even disclaiming any allegiance to the parent science. Nothing but confusion and disaster can result from such a condition.

Contrary to what is sometimes affirmed, botanists are still studying the flora of the country. In some quarters there has been expressed the fear that field botany has disappeared from the schools and colleges, but this is far from true. While it no longer claims the larger part of the student's attention, it is still an essential part of the training of every botanist, and it is probably true that in some cases there is even more field work required to-day of young botanists than its importance demands. Certainly in one kind of field work I should like to see some of the energy and ability now given to the discovery of means for splitting old species turned towards the solution of problems pertaining to growth and development and reproduction. But the careful field study of what plants grow here and there, and why they do so, is greatly to be commended. The sociology of plants, or, as we call it, ecology, has given in the last few years a new reason, as well as a new direction to field botany.

The systematic botany of to-day continues to concern itself more with the distinction of species than with their origin, and this has brought to this department of the science an increased narrowness which has greatly injured its usefulness. On the other hand, plant-breeding, which should be the experimental phase of systematic botany, has had no connection with it. And, strangely, systematic botany, which should welcome plant-breeding as an ally in its quest as to the meaning and origin of species, has been scarcely at all interested.

Let us turn now to the future of botanical science, and endeavour to trace its more profitable course of development during the next one or two decades. What are seemingly to be the demands of modern society upon this science? What are to be some of the next steps in its evolution? For whatever we may say in regard to the independence of science we cannot escape the fact that it must serve its "day and generation." No science can hope for support or recognition that does not respond to the demands of its age.

My first inquiry may well concern itself with the content of botanical science in the immediate future. As we become better acquainted with it and recognise more clearly its relations to the activities of the community we shall be able to define its proper content with more accuracy. And let no man attempt to belittle the importance of such an undertaking. I am well aware of the impossibility of absolutely delimiting botany from every other science, and especially of doing so with reference to many of its applications, and I am fully aware of the fact that the limits of any science are subject to change with the progress of human knowledge. Now and then there must be a "rectification of the frontier" in respect to the boundaries of a science. So without doubt we shall have to add to or subtract from the area now allotted to botany.

It still is true that the field of botany may be considered in three parts structure, physiology, and taxonomy. Beginning with such structures as are obvious to our unaided eyes, we have carried our studies to the minute structure of the tissues, and the cells which compose them. We are able now to peer into the protoplasmic recesses of the living cell, and while we cannot say that we have seen life, we have seen where life is, and what it does. Cytology, histology, and morphology in our modern laboratories have greatly changed our conception of the structure of the plant. It is no longer made up of forms to be compared because of their general similarity of outline, or of position in the plant body. The plant as a whole is a community of variously differentiated living units, just as is each of its organs. It is a complex community in which there is a measure of individual independence of the units, along with much of mutual dependence.

This leads me easily to that portion of the field of botany that has to do with the activities of plants and their organs—physiology the scope of which has been so greatly extended in these later years. Here such inquiries as those pertaining to nutrition, growth, sensibility, reproduction, are of primary importance. The introduction of the experimental method of inquiry has made this a favourite department of the science. Who does not enjoy catching a plant, tying it up in a corner, and compelling it to do something, while we watch for the result? This kind of study appeals especially to those who are looking for demonstrations, and for this reason plant physiology has been increasingly popular. Some botanists, indeed, have gone so far as to insist upon giving first place to physiology. Yet it is well for us to remember that the plant is first of all a structure the complexity of which may well challenge the most acute minds. We find it far easier to record the responses of plants to our planned stimuli than to unravel a structural complex, and so no doubt we shall continue to entertain ourselves and our students with what are too often futile experiments.

In this part of the botanical field are pathology, which grew up from our observation that organs may not respond normally; ecology, which developed from the observation that plants tend to live in communities; and phytogeography, having to do with the means for, and the results of, distribution.

Taxonomy, or, as we used to call it, classification, occupying the third division of the field of botany, long received the almost exclusive attention of botanists. And even to-day it is the pretty general opinion of our non-botanical friends that we are constantly employed in collecting specimens, and in some intricate and mysterious way determining their classification and affixing to them their proper Latin names. And it must be admitted that every botanist does a good deal of just such work.

When the doctrine of evolution came into botany it brought with it the idea of descent, and thereafter taxonomy included phylogeny. To-day the taxonomist is no longer content to stop with a knowledge of the structural differences between plants; he must know how this structure arose from that; he must know which is the primitive structure and which the derived. Phylogeny has so far entered into taxonomy that it has given new meaning to the work of the systematic botanist, and it is bringing into this department of the science something of the philosophical aspect which was nearly wanting heretofore. That this must be the direction of the development of the taxonomy of the future is without question, and we may look confidently for a marked expansion and enlargement of the phyletic idea in botanical taxonomy.

And here I may pause for a moment to advert to a part of taxonomy with which some biologists have little patience, without good reason, as it seems to me. I refer to the matter of taxonomic nomenclature, which has vexed the souls of many botanists, especially during the past one or two decades. However, since every science must have its nomenclature it is childish for us to wish to ignore it in botany.

This contempt for nomenclatural questions is symptomatic of a much-to-be-deprecated state of mind, quite too common among scientific men, especially those who have engaged in special lines of work. I believe in specialisation in botany, but specialisation should not degenerate into narrow bigotry.

Quite easily this leads to a consideration of the personality of the botanist of the immediate future. What manner of man will he be? What will be his training? In other words, what will the future demand of the botanist? For it does not need argument to show that the men engaged in botanical work in the future will be developed and fashioned in response to the demands of the community.

If I interpret aright the movement of modern society as a whole, it is going to result in a demand for two things that by many are thought to be opposite and antagonistic—specialisation and breadth. The first it will demand of its experts, the men who are set aside to solve particular problems for the community. In most cases these will be economic problems of immediate importance to the community, but there is no reason why in the most intelligent communities they should not be scientific problems, of more remote importance. No doubt there will be a demand for many such experts, each of whose tasks will be restricted to but one problem. The only requirement laid upon these men will be that they can do the work to which they have been assigned, and the more restricted the problem the narrower may be the preparation of the expert.

But while the community is certain to increase its demand for botanical experts, we must not overlook the fact that with this demand will come another much more imperative for men of far greater breadth and depth of knowledge, who, in addition to training the botanical experts of various kinds for the community, are able to bring the science as a whole before the youth of the land as a part of the scientific culture which modern society requires. These must be men of the broadest training; men whose sympathies are not bounded by the one science which they know, much less by one phase of botanical science; men who, knowing well their one science, know also much of the related sciences; men who, in addition to a knowledge of science, bring to their students and their community the results of that broader view which relates botany to the life and activities of the community. Such men bear the name of botanists worthily, and justify the contention of scientific men that science may contribute more than material good to the community. These are Lord Bacon's "lamps" and "interpreters of nature."

Turning now to the institutions of learning—the colleges and universities—where botany holds a place as one of the sciences, let us ask what we may look for in regard to its development. In every proper college the department of botany exists primarily for its teaching function, and this is true also for nearly every university. And while we may hope to make every such department a centre of investigation also, it is true now, and it must always be true, that in our educational institutions the teaching of the science must be the primary object of every one of its scientific departments. So the future will call for much more of definiteness as to the content and sequence of the science, as well as the manner of its presentation; its pedagogics, if you please.

The college and university departments of botany in the near future will arrive at a clearer notion as to the essentials of the science as a subject of study. It seems to one who carefully looks over the field that there is often only the most vague notion of the relative importance of the known facts in regard to plants, those of trivial importance receiving as much weight, perhaps, as those of profound significance. Especially is this true of the more elementary courses, in which there is also the greatest diversity in the presentation of the subject-matter. It should not be long until this vagueness and doubtfulness as to substance and manner in the presentation of botany in the high school, and in the college, and the university, will be a thing of the past. And I appeal to botanists to take up seriously the task of so arranging and coordinating our work that botany shall no longer suffer the reproach of being the most chaotic of the primary sciences.

But the college and university departments are by no means all that are engaged in botanical work. Within the past twenty-five years many stations have arisen in which botanical investigations are made. Under various local names they are, in fact, "investigation stations," and while their results have not been uniformly trustworthy, it is a most hopeful sign of progress that they exist at all. Foremost among these are the fifty or more agricultural experiment stations to which I have already briefly referred, with assured support from the States and the national Government for all time to come, in which botanical investigation forms no inconsiderable part of the work undertaken. If I read aright the tendencies in these stations, it will not be long until their scientific output will be wholly trustworthy, as indeed it is now in some cases. This condition will be fully realised when these stations are wholly under the direction of men of broad scientific training.

We must recognise the agricultural experiment stations as permanent parts of the botanical equipment of the country. They will be with us in the future, and their results will continue to be added to botanical knowledge. We must accept them as a part of our scientific equipment, and help to make them more efficient. It will not do for us to stand aloof, and decry their results as not accurate, and as agricultural instead of botanical. When we fully realise that we have in these experiment stations so many institutions of endowed research, we shall not hesitate to welcome them to the ranks of science.

Already we have stations for the study of plants under particular environments, as our seaside stations, our mountain stations, and a single desert station. I take it that these are suggestive of what are to come in the future. Instead of trying to make seaside conditions away from the sea, we go to the sea and there set up our laboratories. So when we want to know how plants behave in the desert we go to the desert. And this is no doubt to be the direction of botanical investigation. We are going to study plants under their natural environment, and to the seaside laboratories we shall add (as indeed we have already to a limited extent) lakeside laboratories, riverside laboratories, swamp laboratories, forest laboratories, field laboratories. Already the tropical laboratories, in Java, Ceylon, and Jamaica, have justified themselves, and no doubt to these we shall soon add Arctic and tundra laboratories. All this signifies that more and more we are going to see what the plant is doing in its natural environment, and then we can undertake intelligently to watch it under a changed environment. So the future is to witness a great increase in the number of these laboratories, and how far it will go can only be conjectured.

Yet when we think of these botanical stations the laboratories of which are taken afield, as it were, we must not suppose for a moment that the old-time laboratories on the university campus are to be abandoned. Far from it. As the work in the field laboratories is enlarged there will be still greater need of the far more exact work that can be done only in laboratories where every factor can be perfectly controlled. There will still be need—greater need I might say—for perfectly constructed plant-houses in which we may observe plants under controlled conditions.

Another kind of station, of which we have now only the beginnings, is one which will carry the results of plant-breeding into the domain of phylogeny. Of this we have now some faint suggestions, which must grow into far-reaching results under the direction of men who know more of the subject than we do now. In such laboratories we shall be able to see how evolution has contributed to the present wonderful diversity of form and size and colour and habit among related plants. Such laboratories will enable us to answer the demand formerly so often made, but less often heard now, for a demonstration of cases of actual evolution.

I am assured as I consider the trend of scientific thought that there will be greater unity of action among the botanists of the country. At present we are still in the guerilla stage of botany, in which every man acts independently and for himself. Although we profess to be botanists acting for the best interests of science, we have actually no uniform standard by which we may measure our actions. In one particular we have tried to set up a standard, in certain international rules pertaining to nomenclature; and yet, after several congresses of botanists, we have the humiliating spectacle of a set of laws that nearly everybody disobeys!

As I look into the future a vision rises before me of the scientific army, working harmoniously like well-drilled soldiers, and not wasting their strength by turning their guns on one another. In this army of science I see a company of thoroughly disciplined botanists, who, in orderly fashion, plan their campaign. And, from the many doing severe garrison duty in the small colleges to the heavy artillerymen in the big university fortifications, and the few isolated scouts along the frontier of special investigation, all are actuated by a common spirit of scientific patriotism and loyalty.

This, my botanical brothers, is what the future is bringing us—a united, harmonious body of trained men, whose endeavour is to carry forward the banner of science, not for personal advantage, but for the glory of the science to which we have dedicated our lives.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Prof. Charles Lapworth has expressed the desire to vacate the chair of geology in the University at the end of the current session. The council of the University has resolved to engross and present to him the following resolution:—"That in accepting the resignation of Prof. Lapworth, first professor of geology, the council remember that he was appointed to the chair so long ago as 1881, that he has had full charge of the department ever since, and built it up into the most prominent and successful chair of geology in any British university. The Geological Surveys of the Empire also owe some of their methods to Prof. Lapworth's genius, and his name is of more than European reputation. They thank him for his long and assiduous services, continued to a period late in life, and hope that he will long enjoy the comparative leisure and still useful work that they anticipate await him in the future."

CAMBRIDGE.—The Gordon Wigan income for 1912 at the disposal of the special board for biology and geology has been applied as follows:—(*a*) 20*l.* to Prof. Hughes for research among the Pleistocene deposits of the Cambridge district; (*b*) 50*l.* to Prof. Punnett in order that the Botanic Garden Syndicate may continue to offer special facilities for plant-breeding experiments; (*c*) 50*l.* to H. Scott, curator in entomology, for the care and development of the collections of insects; (*d*) 30*l.* to Prof. Langley, towards the cost of an X-ray installation in the new physiological laboratory.

It is proposed to confer the degree of master of arts, *honoris causâ*, upon Mr. G. Udny Yule, University lecturer in statistics.

The Right Hon. Lord Walsingham, of Trinity College, Dr. Shipley, master of Christ's College, and Prof. Punnett have been nominated to represent the University at the ninth International Congress of Zoology, to be held at Monaco in March.

LIVERPOOL.—The council of the University on January 28 appointed Dr. J. W. W. Stephens to the Sir Alfred Jones chair of tropical medicine, vacant through the resignation of Sir Ronald Ross. Dr. Stephens has held the Walter Myers lectureship in tropical medicine at the University, and has been associated in the teaching work of the Liverpool School of Tropical Medicine for ten years.

LONDON.—At the meeting of the Senate on January 22, Dr. Frederick G. Donnan, F.R.S., was again appointed to the chair of general chemistry, tenable at University College, recently vacated by Sir William Ramsay, F.R.S. Prof. Donnan was appointed to this chair some months ago, but for private reasons was unable to accept the appointment.

The anonymous benefactor who presented 30,000*l.* for additional buildings in front of University College has increased his original benefaction. He will now bear almost the whole cost of the buildings in question.

OXFORD.—The Herbert Spencer lecture will be delivered by Prof. D'Arcy Thompson on Friday, February 14, and not on February 13 as previously announced.

Prof. Poulton, F.R.S., Prof. Bourne, F.R.S., and Mr. E. S. Goodrich, F.R.S., have been appointed to represent the University at the International Congress of Zoology, to be held this year at Monaco.

THE fifteenth annual dinner of the Old Centralians—the City and Guilds College Old Students' Association—will be held on Saturday, February 15, at the Trocadero Restaurant, Piccadilly Circus, W. The chair will be taken at 7.30 p.m. by Sir John Wolfe Barry, K.C.B., F.R.S., the president of the association. Further information and tickets (price 6*s.* 6*d.*) can be obtained from Mr. G. W. Tripp, 4 Fairfield Road, Charlton, Kent.

A REUTER message from Capetown states that the South African University Bill, which has now been published, provides that the Cape University shall become the national residential University for South Africa, and that its central seat shall be located on the late Mr. Rhodes's estate at Groote Schuur. It permits local as well as central faculties, prohibits religious tests, and provides for instruction and examination with either English or Dutch as medium. It also permits the sale of the Frankenwald estate at Pretoria, presented by the late Mr. Alfred Beit for educational purposes, the proceeds being applied to the University. The Bill further renounces Mr. Beit's gift of 200,000*l.* towards a Johannesburg University.

A COURSE of weekly lectures on mining hygiene and mines rescue work began on January 27 at the University of Leeds. Most of the lectures will be given by Mr. R. Veitch Clark, assistant medical officer for Leeds, but those on rescue appliances and the organisation of rescue work will be entrusted to Mr. David Bowen, acting head of the department of mining in the University. The course has been arranged to meet the needs which have arisen out of recently enacted mining regulations. The Coal Mines Act of 1911 has made it incumbent upon coal-owners to provide sanitary conveniences in mines, both above and below ground. It requires, moreover, that when any rock-drill work by mechanical power is used in a mine, a spray of water must be worked in conjunction with the drill, to prevent the escape of dust into the air, with the view of assisting the prevention of miners' phthisis. The Act, too, empowers the Home Secretary to require the maintenance of rescue and ambulance appliances and the formation of rescue and ambulance brigades. Serious efforts are demanded if ankylostomiasis is to be stamped out, and nystagmus prevented among the miners. It is hoped that the course of lectures, by educating masters and men engaged in the mining industry, will assist very materially in improving the conditions under which miners work. Arrangements have also been made in the University for a special course of lectures on the economic aspects of mining.

THE fifth annual dinner of old students of the Royal College of Science, London, held on January 25 at the Monico Restaurant, was rendered memorable by a speech from Sir William Crookes, O.M., F.R.S., who presided, in response to the toast of the evening, proposed by Sir David Prain, F.R.S. Sir William Crookes recalled the position of scientific investigation when he was a student of the Royal College of Chemistry sixty-five years ago. Of special interest was his personal recollection of Faraday's experiment at the Royal Society in 1850, when he demonstrated the magnetic character of oxygen. He predicted that the practical side of chemistry in the future would be synthetic, and on the philosophic side the investigation of the constitution of matter would make the greatest progress. Miss E. N. Thomas proposed "The Guests," to which Dr. R. T. Glazebrook, F.R.S., and Sir Robert Morant, K.C.B., replied. The latter appealed in eloquent terms for the cordial co-operation of old students in the great educational developments which were imminent in London. He said that the College of Science was obviously destined to be one of the great strong elements of a vivifying kind in the higher education of London. The guests included also Sir Amherst Selby-Bigge and Sir Alfred Keogh, and, among some seventy old students present, Sir Thomas Holland, F.R.S., Sir Alexander Pedler, F.R.S., Prof. A. Fowler, F.R.S., Dr. A. E. Tutton, F.R.S. (the newly elected president of the Old Students Association), and Prof. W. Watson, F.R.S.

THE Chadwick Trust, founded in 1895, under the will of the late Sir Edwin Chadwick, K.C.B., has arranged for a series of public lectures to be delivered during this year, in London and certain provincial towns. The object of the trust is the promotion of sanitary science in all or any of its branches in various ways indicated by the founder, or otherwise at the discretion of the trustees. The first of the courses of lectures will be given on Friday evenings, February 7, 14, and 21, at the Royal Sanitary Institute, Buckingham Palace Road, by Mr. H. Percy Boulnois, on hygiene of the home. In April Dr. J. T. C. Nash will give three lectures at the London County Hall, Spring Gardens, on the evolution of epidemics. In June Dr. F. W. Mott, F.R.S., will give a course at the Royal Society of Arts, under the title of "Nature and Nurture in Mental Development." Among the lectures in contemplation for the provincial cities are those on the public milk supply—some criticisms and suggestions from the public health point of view—by Prof. Henry R. Kenwood, at Manchester, and on water supply, with exhaustive consideration of sources, collecting works, conveyance, and distribution, by Mr. E. P. Hill, at Birmingham. All the lectures will be free and open to the public, but will be of a character to attract post-graduate and advanced students of engineering, medicine, and other cognate sciences. The secretary to the trust, to whom all communications should be addressed, is Mrs. Aubrey Richardson, 8 Dartmouth Street, Westminster.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 16.—Sir Archibald Geikie, K.C.B., president, in the chair.—Lord **Rayleigh**: The effect of junctions on the propagation of electric waves along conductors.—W. B. **Hardy**: The influence of chemical constitution upon interfacial tension and upon the formation of composite surfaces.—Hon. R. J. **Strutt**: Duration of luminosity of electric discharge in gases and vapours.—Rev. P. J. **Kirkby** and J. E. **Marsh**: Some electrical and chemical effects of the explosion of azoimide. The experiments consisted in exploding azoimide gas (HN_3) at low pressures between two insulated coaxial cylinders, of gilded brass, connected to the terminals of a battery of about 105 volts. The quantity of electricity that reached one of the cylinders was measured by a ballistic galvanometer and compared with the quantity of gas exploded. The results show that, in every case, the number of molecules of gas exploded was more than 100,000 times the number of pairs of gaseous ions observed. This disproportion indicates that the atoms of the gas when separated by the explosion do not carry electric charges. The gaseous ions are probably produced by favourable collisions of free atoms in the process of forming the products of the explosion.—Dr. G. J. **Burch**: Negative after-images with pure spectral colours. The results obtained by Mr. A. W. Porter and Dr. Edridge-Green in their experiments on negative after-images and successive contrast with pure spectral colours (Proceedings B, vol. lxxxv., p. 434) can be explained in accordance with the theory of Thomas Young if the "stray light" referred to by the authors is taken into account. Thus fatigue by red light renders the blue and violet of a spectrum projected on a screen in an imperfectly darkened room darker and bluer along the line of the after-image, because it removes the red constituent of the "stray light" with which they are contaminated. The results of fatigue with other spectral colours may be similarly explained. H. **Hartridge**: Factors affecting the measurement of absorption bands. Dr. G. **Barlow**: A new method of measuring the torque produced by a beam of light in oblique refraction through a glass plate. According to theory, the torque produced on a glass plate by the nearly normal passage of a beam of light is directly proportional to the angle of incidence and always tends to turn the plate further from the normal position. The period of small torsional oscillations of a plate suspended by a quartz fibre should therefore be increased when the plate is traversed by the light. An experiment is described in which this change in period, actually an increase of about ¼ per cent., was measured. The observed change agreed within 3 per cent. with that calculated from theory.—Dr. F. **Horton**: The positive ionisation produced by platinum and by certain salts when heated. The emission of positive electricity from platinum and from several samples of aluminium phosphate and of sodium phosphate has been investigated at different temperatures, observations being made of the variation of the emission with time and with the pressure of the surrounding gas.—Clive **Cuthbertson** and Maude **Cuthbertson**: The refraction and dispersion of the halogens, halogen acids, ozone, steam, oxides of nitrogen and ammonia, and the causes of the failure of the additive law. The refraction and dispersion of the elements and compounds named in the title have been determined between $\lambda = 6708$ and $\lambda = 4800$.—R. **Donald**: Liquid measurement by drops. To apply measurement by drops to various serological and bacteriological estimations of liquids and liquid suspensions, the author has worked out a system of using practically uniform easily-made pipettes of any size under any required constant pressure. The pipettes of suitably drawn-out glass tubing are simply gauged in, *e.g.* the Morse drill and wire gauge. The constant pressure is obtained by a column of mercury flowing as a piston to and fro in a suitable glass tube held at any required angle in a stand, or, for less exact work, in the hand. Prof. W. H. **Young**: The new theory of integration. The present communication is a sketch of a mode whereby the modern theory of generalised, or Lebesgue, integration may be developed without the aid of the theory of sets of points.

Mineralogical Society, January 21.—Dr. A. E. H. Tutton, F.R.S., president, in the chair.—T. V. **Barker** and J. E. **Marsh**: Optical activity and enantiomorphism of molecular and crystal structure. The general nature of enantiomorphous structures accompanying optical activity in the liquid and crystalline conditions was discussed, and it was pointed out that, since the optical activity observed in crystals of six substances, including epsomite and sodium chlorate, cannot be referred to the crystal structure, it must be due to an enantiomorphous configuration of the atoms within the molecule. Suitable enantiomorphous configurations have been deduced on chemical grounds, the constitution of the compounds being based on a modification of Werner's theory of co-ordination. The symmetry of the new spatial formulæ is in many cases identical with the symmetry of the crystal, and, in particular, sodium nitrate can best be regarded as a racemate due to a mutual interpenetration of optical antipodes having spatial configurations similar to those suggested for the active forms of sodium chlorate, the symmetry of the double molecule being identical with that of a rhombohedron. The same type of molecular structure presumably exists in calcite and the rhombohedral form of sodium chlorate which crystallises at high temperatures. It is concluded that many cases of dimorphism are of an analogous character, and, more generally, that polymorphous change is preceded by a rearrangement of the atoms within the molecule.—H. **Collingridge**: Note on the determination of the optic axial angle of crystals in thin-section. In the case where one optic axis is visible in the field of view the position of the second axis may be determined more conveniently than in the Becke and Wright methods from the optic axial plane and the extinction direction through the centre of the field. Dr. G. F. H. **Smith**: Graphical determinations of angles and indices in zones. Two methods were described, which, unlike the moriogram, are not restricted to right-angled zones. In one a double tangent scale is placed on a pencil of lines spaced as in a gnomonic projection on a zonal plane in such a way that the 01 and 11 lines cross the scale at the given angles; the angles corresponding to any indices, or *vice versâ*, are read off directly within the limits of the scale. In the second method a double diagram is employed, of which one-half is a new form of the moriogram, and the other is a representation of angles the cotangent of which is the difference of the cotangents of the given angles; the method is general and unrestricted in its application.—Dr. J. **Drugman**: The Goldschmidt apparatus for cutting models of crystals. The mechanism was described and the method of using it explained.—Prof. H. L. **Bowman**: A nodule of iron pyrites. The octahedral shape and the striations on the faces truncating the coigns of the tiny crystals point to their being pyrites and not marcasite, as usually stated.

PARIS.

Academy of Sciences, January 20.—M. F. Guyon in the chair.—A. **Lacroix**: The mineralogical and chemical constitution of the volcanic lavas of the centre of Madagascar. Analyses of twenty-seven typical rocks are given. The materials derived from the two volcanic centres are analogous but not identical.—Pierre **Duhem**: The adiabatic stability of equilibrium.—Paul **Sabatier** and M. **Murat**: Preparation of the three cymenes and the three menthanes. The ortho-, meta-, and para-dimethylcresylcarbinols were prepared by three different methods, these dehydrated by passing over thoria at 350° C., and the cresyl-propenes, $CH_3.C_6H_4.C(CH_3)=CH$, reduced with hydrogen in presence of nickel to the three cymenes, $CH_3.C_6H_4.CH(CH_3)_2$, and ultimately to the corresponding menthanes, $CH_3.C_6H_{10}.CH(CH_3)_2$. The physical properties of all these compounds are given.—Paul **Richer**: The identification of the supposed skull of Descartes by its comparison with portraits. The skull preserved at the museum corresponds very closely with the portrait of Descartes by Franz Hals.—Henri **Chrétien**: The general magnetic field of the sun.—G. **Fayet**: The next return of the Finlay comet; disturbance of the orbit due to the action of Jupiter. An approximate calculation of the orbit after passage of the comet within the sphere of attraction of Jupiter. In its changed position the conditions of visibility will be very unfavourable.—Georges **Giraud**: Certain functional equations and the permutable transformations.—M. **Nörlund**: The problem of Riemann in the theory of equations of finite differences.—Louis **Bachelier**: Semi-uniform probabilities.—Ét. **Delassus**: The various forms of Dalembert's principle, and the general equations of motion of systems submitted to linkages of any order.—M. **Mesnager**: A paradox of uniformly loaded rectangular plates.—E. **Fichot**: The production of static tides of the second kind in an ocean obeying any law of depth.—Vasilesco **Karpen**: The flight of birds without motion of the wings.—Émile **Borel**: The theory of relativity and kinematics.—C. **Dauzère**: Isolated cellular vortices.—J. **Guyot**: Differences of contact potential between a metal and electrolytic solutions.—E. J. **Brunswick**: Predetermination of the characteristics of continuous-current dynamos.—A. **Leduc**: Latent heats of evaporation and maximum pressures. An application of the Clapeyron formula to the calculation of latent heats, the specific volume of the saturated vapour being calculated by methods previously described by the author. Figures are given for water, ether, and benzene; the deviations from the experimental results are considerable.—E. **Briner** and M. **Boubnoff**: Chemical reactions in compressed gases. Study of the decomposition of nitric oxide. The decomposition of nitric acid is accelerated by pressure. The products of the reaction at 300° under high pressure include N_2, N_2O, N_2O_3, and NO_2.—Victor **Henri** and René **Wurmser**: The law of elementary photochemical absorption. The law is enunciated that the photochemical susceptibility of a body depends on that part of the absorption spectrum which corresponds to the same molecular groupings as those on which the reaction is produced.—Daniel **Berthelot** and Henry **Gaudechon**: Action of the middle and extreme ultra-violet rays on ethyl aldehyde: acidification, polymerisation, resinification. In the absence of oxygen the ultra-violet rays cause a simultaneous oxidation and reduction. The production of the polymers, metaldehyde and paraldehyde, and some aldehyde resin was also proved.—J. **Bougault**: Phenyl-α-oxycrotonic acid.—E. E. **Blaise** and E. **Carrière**: Succinic acid aldehyde. An attempt to clear up some discrepancies between the work of Carrière and that of Harries on the polymers of the acid aldehyde of succinic acid.—A. **Mailhe**: The nitro-derivatives of the oxides of ortho-cresyl and orthocresylene.—M. **Trabut**: The infectious chlorosis of the Citrus. This is transmitted by grafts, but numerous attempts to find a bacillus to account for the disease have proved fruitless.—M. **Chantemesse**: Preventive vaccination against typhoid fever in the navy. A comparison between vaccinated and unvaccinated persons, subjected to the same environment, shows that about 1 per cent. of the unvaccinated contracted typhoid fever, whilst not a single case occurred amongst the vaccinated.—M. **Rappin**: Antituberculous vaccination in the guinea-pig.—Raphael **Dubois**: Anæsthesia by the digestive canal. Anæsthesia caused by the rectal injection of chloroform ought to be rejected.—M. **Pézard**: Measurement of the reflex excitability of the spinal marrow and its variations under the influence of injections of solutions of calcium chloride.—Etienne **Rabaud**: The cryptocecidia of *Balanius nucum*, and the biological signification of galls.—A. **Labat**: The presence of bromine in the normal state in human organs. Bromine is normally present in the thyroid gland and in the urine.—Charles **Lepierre**: The non-specific action of zinc as a biological catalyser in the culture of *Aspergillus niger*. Its replacement by other elements. Cadmium has precisely the same influence as zinc in the growth of this mould.—Gabriel **Bertrand** and M. and Mme. **Rosenblatt**: The activity of Koji sucrase in presence of various acids. R. **Fosse**: The formation of urea by two moulds. *Aspergillus niger* grown on a modified Raulin solution containing ammonium nitrate contains urea in its cells; *Penicillium glaucum* behaves similarly.—H. **Bierry**: The diastatic hydrolysis of glucosides and galactosides.

BOOKS RECEIVED.

Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of s.y. *Scotia* during the Years 1902–3–4, under the Leadership of Dr. W. S. Bruce. Vol vi., Zoology. Parts i. to xi., Invertebrates. By Dr. C. Vaney and others. Pp. viii+353+plates. (Edinburgh: The Scottish Oceanographical Laboratory; Oliver and Boyd.) 30*s*.

A First Book of Experimental Science. Arranged By W. A. Whitton. Pp. vii+137. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Das meteorologisch-magnetische Observatorium bei Potsdam. Pp. 81+plate. (Berlin: Behrend and Co.) 3 marks.

Terminologie der Entwicklungsmechanik der Tiere und Pflanzen. By Profs. C. Conrens, A. Fischel, and E. Küster. Edited by Prof. W. Roux. Pp. xii+465. (Leipzig: W. Engelmann.) 10 marks.

Royal Society of London. Catalogue of Scientific

Papers, 18[illegible]-1900. Subject Index. Vol iii., Physics. Part i., Generalities, Heat, Light, Sound. Pp. c+500+vii. (Cambridge University Press.) 18s. net.

Geological Literature added to the Geological Society's Library during the Year ended December 31, 1911. Pp. 164. (London: Geological Society.) 2s.

The Positive Evolution of Religion: its Moral and Social Reaction. By F. Harrison. Pp. xx+267. (London: W. Heinemann.) 21s. net.

Researches in Colour Vision and the Trichromatic Theory. By Sir W. de W. Abney. Pp. xi+418+v plates. (London: Longmans and Co.) 21s. net.

Egyptian Government. Almanac for the Year 1913. Pp. vii+212. (Cairo: Government Press.) P.T.5

The Gas, Petrol and Oil Engine. Vol. ii., The Gas, Petrol and Oil Engine in Practice. New and Revised Edition. By Dr. D. Clark and G. A. Burls. Pp. viii+838. (London: Longmans and Co.) 25s. net.

Year Book of the Indian Guild of Science and Technology, 1912. Pp. 193. (Letchworth: The Letchworth Printers.)

DIARY OF SOCIETIES.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—The Formation of Usually Convergent Fourier Series: Prof. W. H. Young.—The General Theory of Elastic Stability: R. V. Southwell.—A Spectro-photometric Comparison of the Emissivity of Solid and Liquid Copper and of Liquid Silver at High Temperatures with that of a Full Radiator: C. M. Stubbs.—A New Analytical Expression for the Representation of the Components of Diurnal Variation of Terrestrial Magnetism: G. W. Walker.—An Investigation into the Magnetic Behaviour of Iron and some other Metals under the Oscillatory Discharge from a Condenser: Prof. E. W. Marchant.—The Spontaneous Crystallisation and the Melting and Freezing-point Curves of two Substances which form mixed Crystals and the Freezing Point Curve of which exhibits a Transition Point. Mixtures of p. Bromonitrobenzene and p. Chloronitrobenzene: Florence Isaac.

ROYAL INSTITUTION, at 3.—Recent Research on the Gas Engine: Prof. B. Hopkinson.

CONCRETE INSTITUTE, at 7.30.—The Settlement of Solids in Water and its Bearing on Concrete Work: Dr. J. S. Owens.

SOCIETY OF DYERS AND COLOURISTS, at 8.—The Possibilities of a Standard Light and Colour Unit: J. W. Lovibond.—A Simple Method for Detecting Silk, Cotton and Wool Fibres in Admixture in Textiles: W. P. Dreaper.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—The Poetry and Philosophy of George Meredith: G. M. Trevelyan.

MONDAY, FEBRUARY 3.

SOCIETY OF ENGINEERS, at 7.30.—The Bus *v.* Tram Controversy, and other Aspects of the London Traffic Problem: Wm. Yorath Lewis.

ROYAL SOCIETY OF ARTS, at 8.—Liquid Fuel: Prof. V. B. Lewes.

ARISTOTELIAN SOCIETY, at 8.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Behaviour of Paint under the Conditions of Practice with special reference to the Aspersion cast upon Lead Paints: H. E. Armstrong and C. A. Klein.—The Technical Production of Ethane: C. Sprent.—The Feeding Value of the Horse Chestnut: S. J. M. Auld.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Canals and Canalised Rivers: J. A. Saner.

VICTORIA INSTITUTE, at 4.30.—Vision, in Sacred and other History: Rev J. H. Skrine.

TUESDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 3.—The Heredity of Sex and some Cognate Problems: Prof. W. Bateson.

RÖNTGEN SOCIETY, at 8.15.—The Construction of Induction Coils: R. S. Wright.—A Simple Method for Inserting Radium into Lengths of Sterile Rubber Tubes: C. E. S. Phillips.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. VIII. Some Species of Ichthyotaenia and Ophiotaenia from Ophidia: Dr. F. E. Beddard.—Report on the Deaths which occurred in the Zoological Gardens during 1912: H. G. Plimmer.—The Anterior Ambulacrum of *Echinocardium cordatum*, Penn., and the Origin of Compound Plates in Echinoids: H. L. Hawkins.—Plankton from Christmas Island, Indian Ocean. II. Copepoda of the Genera Oithona and Paroithona: G. P. Farran.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Cave Exploration in Gibralter in September, 1912: Dr. W. L. H. Duckworth.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* The Canton-Kowloon Railway (Chinese Section): F. Grove and B. T. B. Boothby.—The Canton-Kowloon Railway (British Section): G. W. Eves. *Probable Paper:* The Erection of the Boucanne River Viaduct, Canada: P. L. Pratley.

WEDNESDAY, FEBRUARY 5.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Antipyrine in Toxicological Analysis: G. D. Lander and H. W. Winter.—The Accurate Determination of Carbon Dioxide in Carbonates: F. S. Sinnatt.—A New Method for the Volumetric Estimation of Chromium, Vanadium and Iron in Admixture: F. W. Atack. Note on Hardened Oils: A. W. Knapp.

ROYAL SOCIETY OF ARTS, at 8.—The Economic and Hygienic Value of Good Illumination: Leon Gaster.

GEOLOGICAL SOCIETY, at 8.—Two Deep Borings at Calvert Station (North Buckinghamshire), and on the Palæozoic Floor North of the Thames: Dr. A. M. Davies and J. Pringle.—The Skeleton of *Ornithodesmus latidens* from the Wealden Shales of Brightstone Bay (Isle of Wight): R. W. Hooley.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Influence of the Resilience of the Arterial Wall on Blood Pressure and on the Pulse Curve: S. R. Wells and L. Hill.—The Occurrence of a Ganglion in the Human Temporal Bone not hitherto described: A. A. Gray.—The Action of Adrenin on Veins: J. A. Gunn and F. B. Chavasse.—A Preliminary Report on the Treatment of Human Trypanosomiasis and Yaws, with Metallic Antimony: Capt. H. S. Ranken. Further Researches on the Extrusion of Granules by Trypanosomes and on their Further Development. (With a Note on Methods by H. G. Plimmer): Major W. B. Fry and Capt. H. S. Ranken.

ROYAL INSTITUTION, at 3.—Recent Research on the Gas Engine: Prof. B. Hopkinson.

LINNEAN SOCIETY, at 8.—Crosses of a Wild Pea with Cultivated Types: A. W. Sutton.—*Rhexoxylon africanum*, a New Medullosean Stem: N. Bancroft.—Revision of the Linnean Types of Palæarctic Rhopalocera: Dr. R. Verity.

FRIDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 9.—Life in the Great Oceans: Sir John Murray, K.C.B.

SATURDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

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THURSDAY, FEBRUARY 6, 1913.

SOUTH AMERICAN IMPRESSIONS.

South America: Observations and Impressions. By James Bryce. Pp. xxiv+611+maps. (London: Macmillan and Co., Ltd., 1912.) Price 8*s.* 6*d.* net.

H.B.M.'S Ambassador to the United States of America naturally enjoyed inestimable advantages wherever he went, although strictly as a private gentleman, on his well-earned holiday trip of four months, during which he visited Panama, Peru, Bolivia, Chile, Argentina, the Straits of Magellan, Uruguay and Brazil.

It is difficult to find in his book a subject of general interest which has not been but slightly touched, except the prospects for the development of industry and commerce, important topics fully written upon by others; the reader is therefore spared the usual statistical tables drawn up to prove what the particular writer wants to prove. The bulk of this most pleasantly written book is descriptive of the manifold impressions made upon the author by the seven republics. "It is nature that chiefly engages the traveller's mind in Peru and Bolivia, as it is economic development which interests him in Argentina and Uruguay. In Chile and Brazil he must be always thinking of both." Many books have been written on South American scenery since Humboldt gave us his "Aspects of Nature," but they mostly lose themselves in the detailed sojourn of a tropical forest, on the endless plains, the perils of the giant mountains, whilst few, if any, have managed to give, in a few terse sentences, the chief characteristics, natural and human, of the various countries. Our author has this gift, enhanced, no doubt, by his own extensive travels in many distant parts of the world, but at heart he is a loving observer of nature, who therefore dedicates his impressions to his friends of the English Alpine Club, and who also knows that it is the environment, in its wider sense, which makes not only the people, but also their States and their destinies.

Perhaps this is the most valuable practically and philosophically interesting contribution to the study of the social aspects of the South American continent. Its many republics, great and small, prosperous and others still somewhat lagging behind, as our author would put it with his intentional optimism—all have something in common found nowhere else in the world: a Latin stock, essentially Spanish or Portuguese, with an often considerable infusion of native blood, with French, not Anglo-German, culture. Yet there are already marked differences between almost any two of the various republics, some of which have become, others of which are beginning to develop into, true nations with decided national characteristics. Here it is the experienced statesman who reveals to us the causes at work, historical, geographical, sometimes accidental administrative contingencies, with their far-reaching results. The division of the continent between the Spaniards and Portuguese was due to an accident, the famous papal bull having fixed upon a meridian as the demarcation of future conquests which subsequently happened to run through a continent the existence of which was not even suspected. The Spaniards, entering through the back door, by Peru, occupied the north and west, and having extended across the Andes until they arrived at the Atlantic, had to subdivide their unwieldy territory into the viceroyalties of Peru and Buenos Aires. Brazil, the huge share of the Portuguese, was thus hemmed in towards the south and west, at least theoretically, since there are even now wide tracts of land almost unknown and claimed by two, or even three, of the adjacent republics.

There is the important problem of the relation between the white population and the aborigines, in Brazil also the negroes—relations altogether different from those prevailing in North America, because in Mexico, Central and South America there is no colour question. The intermixture between white and brown, continued since the conquest, is producing phenomena of the greatest physiological and ethnological interest. Here the mestizo deems himself a white, tries to live and think as a white, and is practically recognised as such by others. In the Argentine, Uruguay and South Brazil, where the natives have vanished long ago, the pure whites are, of course, increasing; in Peru and Bolivia, with the natives in the overwhelming majority, the process of mixture is so slow that it may take centuries before they form one race and leave no pure Indians remaining. It is an assumption that this aboriginal blood is not beneficial to the developing nations; the Chilean peasant to-day, who is at least half Indian, is not inferior to the Argentine peasant, who is almost pure white. The mestizos and whites are, for political and social purposes, practically one and that the ruling class, the Indians being passive and, in a political sense, outside the nation. Blood is, however, only one factor in the making of men. Environment and the influence of the reigning intellectual type count for more.

South America is the chief resource to which the overpeopled countries may look for their emigration, and to which the world at large may look for augmenting its food supply. Political disorders and difficulty of access, which have given these republics a bad name, no longer apply to its temperate regions. The future of these States is assured so far as the gifts of nature can assure it. The world will always want what they produce. The reclaiming of the tropical parts and their future is not yet a practical question. Such and similar topics are dealt with in the last chapter, entitled "Some Reflections and Forecasts." Here once more it is the experienced statesman who takes his survey from a lofty point of vantage, and for obvious reasons we have now and then to read between the lines, in contrast with the interesting "South America To-day," by G. Clémenceau, the former Prime Minister of France, who, likewise on a rapid trip, lectured the Argentinos on their own social problems. Mr. Bryce's work, although not embellished with pictures, contains several large-scale maps, notably of the Panama Canal and the Straits of Magellan, to which hitherto little-described region is devoted a charming chapter from the historic and scenic points of view.

THE BEGINNING OF A NEW ERA IN MINERALOGY.

Untersuchungen über die Bildungsverhältnisse der ozeanischen Salzablagerungen insbesondere des Stassfurter Salzlagers. By J. H. van't Hoff and others. Herausgegeben von Prof. H. Precht und Prof. Ernst Cohen. Pp. xx + 374 + 8 plates. (Leipzig: Akademische Verlagsgesellschaft m.b.h., 1912.) Price 16 marks.

VAN'T HOFF'S researches on the formation of oceanic salt deposits were originally published in the *Sitzungsberichte* of the Royal Prussian Academy of Sciences. As this periodical is unfortunately inaccessible to the vast majority of scientific workers, the need for a re-publication of the whole series of papers (fifty-two in all) has been keenly felt for a considerable time. Although summaries of the work, or portions of it, have been published from time to time in various readily accessible scientific journals, and although van't Hoff himself published a very concise account of his work ("Zur Bildung der ozeanischen Salzablagerungen," 2 vols., 1905 and 1909, Vieweg und Sohn), those acquainted at first hand with the researches in question have realised that nothing short of a re-publication *in extenso* of the whole series could give that detailed and intimate acquaintance which is necessary for the advance of science. We therefore owe Profs. Cohen and Precht and the Akademische Verlagsgesellschaft in Leipzig a deep debt of gratitude for the publication of this splendid volume.

As all the world knows to-day, van't Hoff's work on the oceanic salt deposits deals in the main with a systematic study of the conditions affecting the formation, decomposition, and coexistence of all the single and double salts, and all the various combinations of these which can appear in the system Na–K–Mg–Ca–Cl–SO_4–H_2O. Borates are also considered and dealt with in a number of interesting papers.

Owing to the enormous labour and time involved, van't Hoff confined his attention in the main to working out the isotherms at 25° and 83°. But the gap between these temperatures was, at any rate as regards the appearance and disappearance of the chief minerals, very largely bridged over by many determinations of vapour-pressures and transition-points. So much so that van't Hoff was enabled to construct what he called a "geological thermometer"; that is to say, he could state at what temperatures various minerals or groups of minerals had in long past ages been deposited. The thirty-sixth paper of the series gives an account of the temperature-limits determining the coexistence, between 25° and 83°, of the various groups of minerals (parageneses). These paragenetic tables might indeed be regarded as the crowning glory of the whole series of researches.

The remark has been sometimes made that van't Hoff's work on the oceanic salt deposits cannot be regarded as equal to his earlier achievements in point of originality and genius. Such remarks arise from that striving after sensationalism and notoriety which is apt to infect science, just as it has infected and corrupted many other departments of life at the present day. In originality of design and method, grandeur of scope and conception, and intellectual power and insight in development, van't Hoff's work on the oceanic salt deposits bears the stamp of sovereign genius. Like every other work of genius, it has had and will have far-reaching results. Not only is it a model for all time of how problems in inorganic chemistry and its technical applications should be studied, but it points the way towards the creation of the mineralogy and geology of the future. Already the Verband für die wissenschaftliche Erforschung der deutschen Kalisalzlagerstätten and the Geophysical Laboratory of the Carnegie Institution at Washington are actively following in van't Hoff's footsteps, so that on the one hand the particular problem he attacked is being completed in its details, whilst on the other the new experimental mineralogy of the future is making rapid progress.

The present volume of collected researches will remain for all time one of the great classics of science, a source of perpetual delight and inspiration to all true philosophers. He who drinks at such fountains can never grow old, for the clear waters that flow therefrom are the true elixir of the human spirit. F. G. Donnan.

PHYSICAL AND CHEMICAL CONSTANTS.

Tables Annuelles de Constantes et Données Numériques de Chimie, de Physique et de Technologie. Vol. i., année 1910. Pp. xxxix + 727. (Paris: Gauthier-Villars; Leipzig: Akademische Verlagsgesellschaft m.b.h.; London: J. and A. Churchill; Chicago: University of Chicago Press.) Price 24*s.* net (cloth); 21*s.* 6*d.* net (paper).

THIS somewhat ponderous volume is the first of a series of the same character it is proposed to publish annually. It comprises a compendium of those constants of physics, chemistry and technology which result from researches published during the year 1910. The volume would appear to bear to Science Abstracts and the Abstracts published by the Chemical Society about the same relation as a dictionary to an encyclopædia. It is compiled under the auspices of an international committee, on which Dr. Wilsmore is the British representative, aided by a number of collaborators and abstractors, the general secretary of the committee and editor-in-chief being Dr. C. Marie, of Paris.

To review and criticise such a work is not easy, and it would be manifestly unfair to treat the volume like a book of tables, looking in it for information on definite subjects and commending or blaming according as one found or did not find what was required. We have some doubt, however, whether any considerable number of workers will be willing to purchase some large book of constants, such as the well-known "Landolt and Börnstein," or the late Mr. Castell-Evans's Chemical-Physical Tables, and use the present publication as an appendix to the same.

The volume is printed on good paper, but a good deal of space seems to have been wasted, making the book extremely bulky. On the whole, it seems fairly easy to ascertain from it whether, during the year it covers, any additions were made to our knowledge in any of the branches dealt with. Pure chemistry, and in particular organic chemistry, occupies a large share of the 727 pages composing it, and it is probably to the chemist rather than to the physicist that it will be of most use. Like most other books of tables, it is quite uncritical in character, and we doubt the utility of a bare statement, such as, for example, that found on p. 227: "Cuivre pur—variation de la résistance en pour cent à 20° = 0·3938," with no details as to the state of the metal or why the constant quoted differs so widely from the accepted value; but, nevertheless, we think that on the whole the work of the abstractors seems to have been conscientiously done.

The English of the book savours in places of an old-fashioned French exercise book; the English translations of French terms used have a look in some instances of having been dug out of a dictionary of the Early Victorian period. Throughout the indexes and in some other places German, English, French, and Italian equivalents are given for titles, etc., but in the body of the work the language used is generally French. Better indexes to the present volume than those which are given are needed, and are promised in the 1911 issue. J. A. Harker.

TWO BOOKS ON NAVIGATION.

(1) *Nautical Astronomy.* By W. P. Symonds. Pp. 130. (London: J. D. Potter, 1912.) Price 6*s.*

(2) *The "Newest" Navigation Altitude and Azimuth Tables for Facilitating the Determination of Lines of Position and Geographical Position at Sea.* Second edition. By Lieut. R. de Aquino. Pp. xlix + 176 + v* + 36*. (London: J. D. Potter, 1912.) Price 10*s.* 6*d.* net.

(1) NAUTICAL astronomy is simply the application of spherical trigonometry to the problem of ascertaining the latitude and longitude at sea by observations of the heavenly bodies; as also the errors of the compass. To a student acquainted with spherical trigonometry it is only necessary to give the figure showing the data available, and the result required, to enable him to make the necessary calculation. Mr. Symonds gives the figures and also some trigonometrical formulæ, as do all other books, or nearly all others, which treat of navigation and nautical astronomy, but his figures are badly drawn, especially Fig. 2 on p. 8.

It is in the practical application for obtaining the data required for calculating a ship's position that Mr. Symonds fails:—(1) No stress is laid on the importance of obtaining the latitude and longitude simultaneously. This can always be done by star observations at twilight, in the morning and evening, when the horizon is sufficiently clear and the stars are plainly visible. It can often be done in the daytime when either Venus or Jupiter passes the meridian between sunrise and 9 a.m., or between 3 p.m. and sunset. (2) No stress is laid on the refraction of the sea horizon, which can only be eliminated by taking observations on both sides. In the case of properly selected stars at twilight, morning and evening, this error can always be corrected; and in obtaining the latitude at noon, by the sun's meridian altitude, it can also be eliminated if the sun is high enough to allow its altitude to be obtained by the north as well as the south horizon.

If observations of one heavenly body are alone obtained, the precise position of a vessel is always open to doubt, as an allowance has to be made for the change in the ship's position, for the time elapsed between the observations for latitude and longitude. This necessitates an allowance for tide and current, which is always uncertain.

(2) Lieut. Radler de Aquino's work is simply an amplification of a problem which has been taught in some navigational schools for more than sixty years and was propounded originally by Captain Thomas H. Sumner, a United States shipmaster, in 1837, as properly stated in a footnote on page ix. of the introduction to this work. It is based simply on the fact that if a line be drawn from the centre of the earth to any heavenly body, at the point where that line cuts the earth's circumference the altitude of that heavenly body will be 90°. If a radius of the earth be taken 10° from the first line and a circle be described on the earth's surface, at every part of that circle the altitude of that heavenly body will be 80°, &c. When, therefore, an altitude of a heavenly body is taken, the observer is on a circle on the earth's surface at every point of which the altitude will be exactly equal to the altitude he has observed, and his position on that circle will be where the true bearing of the heavenly object cuts the circle.

The circles on the earth's surface have such a large radius that they can be treated for short distances as straight lines, by assuming the tangent to the circle to be a line of position on which a ship is situated.

In the days of sailing ships, or of auxiliary powered steamers, these lines of position were used chiefly to obtain the latitude and longitude, as, by observing the altitudes of two or more heavenly bodies suitably situated, as near right angles to each other as practicable, two or more lines of position were obtained at the same time, and the observer's position was in the spot where these lines cut each other.

In these days of full-powered steamers the position line can be made use of to make any particular point on a coast, for if the line of position runs towards the coast a vessel has only to steam along it to arrive at the point on the coast which it cuts. This is not new, but is only practicable in ships of the present day.

In Lieut. Radler de Aquino's book some tables are given by which the problem can be solved without working out the spherical triangle upon which the problem is based, but as the spherical triangle can be worked in about five minutes, there is no particular advantage to an officer in throwing over the system which he *must* understand and be familiar with to be a good navigator, to take up another system in its place, and to crowd the limited space available in ships with works that are not absolutely necessary, more especially as little or no time is saved by doing so.

OUR BOOKSHELF.

Notes on Chemical Research. An Account of Certain Conditions which Apply to Original Investigations. By W. P. Dreaper. Pp. x+68. Price 2s. 6d. net.

MR. DREAPER is the editor of *The Chemical World*, and his "notes" first appeared in that vigorous young journal. They were well worth reprinting; for, although they have the unsystematic character which the title seems to admit, they are informed both by wisdom and enthusiasm and cannot fail to stimulate the young workers to whom they are addressed.

Mr. Dreaper's main thesis is that the researcher "must give special attention to the theoretical side of his science, and train his mind to discover in the recorded work of others the conditions which have led to success." In delivering this opinion he has in view researchers both in "pure" and "applied" science. Indeed, one of the most interesting points in the book is the author's oft-expressed conviction that under modern conditions the dividing line between these two kinds of inquiry has become and will continue to become less marked. It has become necessary for the practical man to keep closely in touch with theory and for the worker in pure science to have some knowledge of industrial experience which is apt—owing to the large scale of the phenomena—to throw important light upon theoretical questions.

This view is excellently illustrated by numerous examples drawn from the present state of pure and applied chemistry. For the rest, it must suffice to add that Mr. Dreaper presents in an attractive and non-technical way a sound philosophy of scientific inquiry. T. P. N.

Elektrobiologie. Die Lehre von den elektrischen Vorgängen im Organismus auf moderner Grundlage dargestellt. By Prof. J. Bernstein. Pp. ix+215. (Braunschweig: F. Vieweg und Sohn, 1912.) Price 6 marks.

PROF. BERNSTEIN'S "Electrobiology" is a particularly fascinating presentation of the electrical phenomena of animal and plant tissues, coloured from beginning to end by the observations and ideas of its author.

The earlier chapters, dealing with historical matter and with the electrical properties of muscle, nerve, &c., lead up to his "membrane theory" of these phenomena. This postulates, for each fibre (or cell), a semi-permeable investment enclosing a fluid of higher ionic concentration than that outside it, and so represents each tissue element plus its immediate environment as a concentration cell.

From this point of view are first discussed currents of injury and of activity—the former attributed to outward diffusion of the cell (fibre) contents ("pre-existence" in a new dress), the latter to excitatory alteration in the permeability of the "membrane." Electrotonic and thermal currents, the discharge of electric organs, and the law of electrical excitation are dealt with from the same point of view.

Nor is this all. "Electrobiology" is extended beyond the above, more obviously electrical, events. In addition, the activity of secreting and of absorbing surfaces, karyomitosis, cell-life in general, are presented as electrokinetic phenomena.

Prof. Bernstein's clearness and conciseness have enabled him to condense a wealth of detail into small compass with singular freedom from confusion. His presentation is impressive and interesting throughout, and it is to be hoped that a work so peculiarly attractive to pre-graduate as well as to post-graduate students of physiology will find its way to early translation. W. L. S.

A Vertebrate Fauna of the Malay Peninsula from the Isthmus of Kra to Singapore, including the Adjacent Islands. Edited by H. C. Robinson. Reptilia and Batrachia. By George A. Boulenger. Pp. xiii + 294. (London: Taylor and Francis, 1912.) Price 15*s.*

This is the first instalment of a vertebrate fauna of the Malay Peninsula of which the Federated Malay States Government has authorised the publication. The plan of the work is that of Blanford's "Fauna of British India," to which it may be regarded as supplementary. References to literature, especially in the case of species common to both fauna, have been made as short as possible, though a fairly full synonymy has been given for all forms which do not occur outside Malayan limits.

The descriptions throughout are based on the collections in the British Museum, supplemented in some few cases by specimens in the Selangor, Perak, and Singapore Museums.

Who's Who in Science: International, 1913. Edited by H. H. Stephenson. Pp. xvi + 572. (London: J. and A. Churchill). Price 8*s.* net.

Several improvements have been made in the 1913 issue of this useful work of reference. A frontispiece giving portraits of certain eminent men of science who died during 1912 has been included, a new section on scientific societies and their publications has been added, and biographies of distinguished workers in psychology and geography are given for the first time. Altogether the editor has provided men of science with a handy directory which should help to introduce them to fellow-workers in various parts of the world.

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.*]

Breath Figures.

Lord Rayleigh, in Nature, December 19, 1912, has again returned to the subject of breath figures, and his criticisms of my work on that subject call for some remarks. Lord Rayleigh holds that clean glass will give a uniform deposit of dew when breathed on, and will look black, to use his expression, and show the colours of thin plates when properly lighted. I, on the other hand, think that the character of the deposit is generally determined by the impurities on the surface of the glass, because the appearance of the deposit depends very much on the treatment the surface may have previously received. I came to this conclusion because there seems to be no way of finding out what the deposit is like on clean glass, as we have no means of knowing whether the surface is clean or not.

My reason for supposing that the black deposit formed on the track over which a blowpipe flame had previously passed was due to impurities deposited on the cold surface by the hot gases, is that we know that under these conditions fine dust and possibly some gases must be deposited on the glass, and it is this impurity which, I think, gives the black deposit. Lord Rayleigh, on the other hand, supposes that this black condensation is due to the cleansing effect of the heat. If this be the case, then heat, apart from the flame, ought to give the same result. In my letter in Nature of June 15, 1911, it is shown that it does not. This experiment was repeated recently, using higher temperatures. The result was no change on testing with the breath; the plate still gave the white deposit. A part of the plate was then passed over the flame, and, though not heated above what could be comfortably handled, it gave the black deposit. The black deposit in this case does not seem to be due to heat, but to some effect of the hot gases which will be referred to later.

On reading Lord Rayleigh's paper I was greatly interested in his happy idea of breaking a piece of glass and testing the broken surfaces before they got contaminated by any impurity. The solution of the question of the nature of the deposit on clean glass seemed at hand, but on further inquiry it became elusive, as we shall see. Following Lord Rayleigh's example, very thick plate-glass was first experimented with. When observing the condensation, in place of breathing on the glass, the plate, with the newly broken edge upwards, was pressed into pounded ice. By causing the condensation to take place in this way we get plenty of time for observing what is taking place. The surface was watched, while the condensation was forming, by means of a strong magnifying lens. My tests of the newly broken surfaces were slightly different from Lord Rayleigh's. He got both kinds of condensation—both black and white—while in my tests scarcely any white was observed. Practically all the surfaces gave a black condensation; they acted as Lord Rayleigh thinks clean glass will act.

Other kinds of glass were also tested. The finest results were obtained with the glass of a common black bottle. The deposit in this glass gave very fine colours, the black background showing them up brilliantly

Having arrived at the conclusion that practically all the newly broken surfaces of glass gave the black condensation, the next question which called for consideration was: What is the condition of a freshly broken surface of glass? While what was now a new surface was still in the interior of the solid it would be in equilibrium with its surroundings; but would it be in equilibrium with its new surroundings? That is: Is a newly broken surface of glass in the same condition as glass as we know it? To get an answer to this question a number of samples of different kinds of glass were broken and placed on a sheet of glass and covered with a glass shade. All the samples were placed with their test surfaces facing downwards to prevent any dust settling on them. When these were examined two days later it was found they had entirely changed; almost no black or iridescent colours could now be seen; nearly all the surfaces gave the white deposit.

It is not necessary to wait so long as two days to find this change in the broken surfaces of glass. If broken one day and examined the next the change is quite evident, and so surprising did this seem that I had to make a fresh break of the same piece to compare the new with the old before I was satisfied that the observation was correct. From this it will be seen that it is possible to say whether or not a piece of glass has been newly broken. The time necessary for this change to take place has not been determined, but probably depends upon the kind of glass used; possibly also the temperature and humidity of the air may have some effect. Wetting the surface causes the change to take place more quickly.

From the foregoing it would appear that the tests made with newly broken surfaces of glass give an uncertain answer as to the nature of the deposit on clean glass. If we look on a newly broken surface as clean glass, then the deposit is black. But if we wait until this surface has acquired its equilibrium in its new surroundings—that is, in the condition in which glass as we know it always is—then the deposit is white, and so far as these tests go the verdict tends to the latter conclusion.

Coming now to the experiments made with glass tubes, in which the influence of the impurities of the flame is eliminated, I found no difficulty in repeating Lord Rayleigh's experiments. In these tests I used a number of different kinds of glass, and all of them, after heating, gave the black deposit, but they varied greatly; some gave black but no colours, whilst others gave good colours. The glass used for ordinary test-tubes gave the best results. Something of this may possibly be due to the composition of the glass. All easily fusible glasses are more soluble in water than the others, and we may presume have a greater affinity for it. In making these experiments it was noticed that little or no effect was produced unless the glass was heated high enough to cause the bunsen flame to be coloured with the sodium of the glass, showing that the glass was undergoing some change.

The test with the tubes having shown that after being heated high enough they gave the black deposit, sheet-glass was again put under investigation to see if higher temperatures would not make it also give the black deposit. In the previous tests it was not found possible to heat the glass very highly; owing to their size and to the want of uniformity in the heating, the plates generally burst in pieces before a high temperature was attained. Thin strips of glass of from $\frac{1}{4}$ to $\frac{1}{3}$ of an inch broad were now used. These were placed on a piece of sheet-iron, about 1 inch broad, and placed over a bunsen flame. With the higher temperature now obtained it was found possible to change the glass and cause it to give the black deposit, but very little colour. As there might be some hesitation in accepting this result, the method of heating was changed. The strip of glass was put inside a tube, and was thus thoroughly protected from contact with the bunsen gases. Strips of glass were heated in iron, brass, and glass tubes, which had been previously highly heated to cleanse them. Under these conditions the highly heated sheet-glass gave the black deposit, but very little colour.

What interpretation are we to put on these tests? One might at first sight say that the heat had cleansed the surfaces of the tubes and sheet-glass, and that purified surfaces gave the black deposit. The observation that the glass had to be heated to a temperature high enough to cause a change to take place in it first raised my suspicions as to the correctness of the above conclusion, so an examination of the surface of the glass was made. Using in the first place the strips of sheet-glass, as observations are more easily made on them than on the less optically perfect glass of the tubes, the first question was: Is the glass clean after being highly heated? It proved to be far from it. If a small piece of wood the thickness of a match be covered with a piece of the polishing cloth and a small surface of the glass be rubbed with it, it will be seen that along the boundary of the rubbed part there is a deposit of dust, rubbed off the plate. This deposit is not seen when a clean part of the plate is rubbed in the same manner; further, with proper lighting and a black background it will be seen that the rubbed part is blacker than the surrounding glass. This observation is much aided if a strong magnifying glass be used. Attention was now directed to the condition of the surfaces in the tubes. Rubbing with a small pad showed that their surfaces also were covered with fine dust. It may also be mentioned that plates that had previously been passed over a bunsen flame or a blowpipe jet could be seen by the same test to be covered with dust.

The question may be asked: Where does this fine dust come from in the tube experiments? The simplest explanation seems to be that it is due to some change produced in the glass by the high temperature. The effect of the heat, therefore, does not seem to be entirely a cleansing one. Of course, it is quite possible that the dust may not be the only cause of the black deposit; the surface of the glass may have been changed in some way by the heat, causing it to form the black deposit. This supposition does not seem to be at all unlikely, as the surface has in all probability been changed by the heat, and if it has been changed it is not likely to be now in a state of equilibrium. Plates and tubes which had been heated were therefore put aside and protected from dust to see if they changed with time like the broken glass. All of them changed more or less towards the white deposit. Sheet-glass was back in two or three days to its usual white deposit. The tubes were slower in changing.

In conclusion, I wish to reply to the two last paragraphs in Lord Rayleigh's article, wherein he describes some experiments in which his experience differs from mine. In the first he says that with an alcohol flame and blowpipe he got the black deposit, while in my tests I only got slight indications. The reason for this difference is very simple. In the previous part of my paper describing this experiment there are noted the effects of the bunsen flame, then those of the alcohol flame; the effects of the two flames are next compared, and, as stated, the alcohol gave very slight results. Lord Rayleigh in his tests used a blowpipe with his alcohol flame, and naturally got a much greater effect.

In the last paragraph Lord Rayleigh says our experiences differ as to the visibility of objects seen through a dewed plate. There are two reasons for this. One is that the test objects were quite different. His was a gas flame, while mine was a landscape, an object much more easily rendered invisible than a flame. The second reason for our difference is that he dewed his plate by breathing on it, and I can quite imagine it would be difficult to get sufficient obscurity by that process. I, on the other hand, dewed mine by cooling the back of the plate with a piece of ice, by means of which any amount of deposit may be obtained. I have lately tried a test object similar to Lord Rayleigh's, using an incandescent gas light. By continuing the cooling and condensation long enough, it was found possible gradually to diminish the visibility of the mantle until it all vanished and only an irregular bright, undefined centre of light remained. John Aitken.

Ardenlea, Falkirk, January.

An Electrical Phenomenon.

The form of high-resistance Bell telephone receiver which of recent years has been evolved for use in some systems of wireless telegraphy, gives us an extraordinarily sensitive means of detecting variable electric currents of a very minute description.

Using one of these instruments, made by Mr. H. W. Sullivan, which is wound with so many turns of very fine wire that it has a resistance of 5000 ohms, I have found at my residence, 40 Chester Square, a somewhat surprising state of things.

Holding one terminal of the telephone in one's hand so as to connect the electrostatic capacity of one's body, and applying the other terminal, which one must be careful not to touch, to any metallic object of considerable size in the house, one immediately hears in the telephone a singing noise. The larger the metallic object and the higher up it is in the house, the louder the sound. The sound is also made louder if one's own electrostatic capacity is increased by contact with another person or with a metallic sheeting. The metal of all the fireplaces gives the sound most distinctly, as does also an iron bedstead on the third floor, which stands on glass castors free from contact with the wall. The sound can be obtained even from the brass stair-carpet rods only about 3 ft. long, particularly towards the top of the house, and it can also be got from the gilt of picture frames. All the curtain-poles give it loudly.

The position of the object from which the sound is obtained does not appear to matter, excepting that, as mentioned, the higher up in the house the louder is the sound.

There seems to be no question that the cause is some form of electrical induction, or wave, from the electricity supply, which is direct current, from the Westminster Company. That this is so is evidenced by the fact that an exactly similar note can be obtained from the supply mains. The sound appears to be due to a ripple superimposed on the continuous current by the commutators of the dynamos, and at times the beat of the fast-running engines, such as do, in fact, supply the current at certain hours, can distinctly be heard. Furthermore, the phenomenon described above ceases the moment the supply is cut off at the house by opening the double-pole main switch.

It should be mentioned that on the top of the house there is an aërial, consisting of a piece of wire-netting 20 ft. by 4 ft. in area, supported on four insulators about 10 ft. above the roof, with a wire coming down from this outside the house and entering a room on the ground floor, the whole being destined for use as a wireless receiving station. It is possible that this aërial may have some influence, but the fact that putting it to earth or leaving it insulated does not seem to have the slightest effect upon the results obtained seems rather to point to an opposite conclusion.

It should, however, be mentioned that with the telephone receiver connected between the wire leading to the aërial and the water-pipe, the singing noise is still very distinctly audible, even after the main double-pole switch is opened, which points to there being a field of force operating on the aërial either from the street mains or from the electric wiring in the neighbouring houses.

Similar experiments at this office, which is also supplied by the Westminster Company, give a very high-pitched but rather faint whistling sound when the telephone is applied either to the water- or the gas-pipe, while the metal of the fireplaces also gives a similar sound, but so very faintly that it is barely discernible. This sound, too, is no doubt due to the high-speed commutators of the turbo-generators which supply this portion of the Westminster system.

A. A. Campbell Swinton.

66 Victoria Street, Westminster, S.W., February 4.

Luminous Halos surrounding Shadows of Heads.

I remember when I was a boy, more than eighty years ago, that I used to notice this luminous halo surrounding the shadow of my head on the water when I was fishing from a bridge in the meadows below Salisbury. I think it was in some way connected with the ripple on the water, which was so clear that I could see the fish. I mention this because similar conditions could be easily met with.

O. Fisher.

Graveley, Huntingdon, January 30.

This phenomenon may sometimes be seen in this country when one's shadow falls on grass. It is not necessary that the grass should be wet, if the leaves have a shining cuticle; but the general direction of the blades (which grow usually more or less parallel to one another) in relation to the position of the sun at the time must be such that its rays strike their surface at an angle approaching a right angle. Under these conditions the blades of grass from which most light reaches the observer's eye are those upon which the sun's rays fall, and are reflected to him, most nearly perpendicularly, and the rays which do so are those which pass closest to his head without being intercepted by it. Hence there appears to him a ring of brighter illumination immediately surrounding the shadow of his head, the effect being heightened by contrast. Farther from the shadow, as the angle of incidence becomes more oblique, the luminous ring becomes gradually merged into the general illumination. The reason why the bright ring is not seen round the lower parts of the body or around the heads of other persons is that these are not so nearly in the direct line of incidence.

The phenomenon "A Shadow and Halo" is described in Nature in 1888 by several correspondents (vol. xxxviii., pp. 540, 589, 619), and its production by reflection from dewy grass is explained on the lines I have mentioned.

An analogous phenomenon is the striped appearance of a lawn or grass field which has been rolled by a roller passing alternately in contrary directions. Where the roller has travelled in a direction from the position of the observer the blades of grass are bent away from him, and he sees light from the sky reflected from the smooth cuticle on their upper surface. Where the roller has travelled in a direction towards the observer the blades of grass are bent over towards him, so that he sees more of their under surface, which, besides being partially shaded, has not so highly reflecting a cuticle as the upper surface, hence these strips appear, in comparison with the first, darker and of a deeper green.

H. FRANKLIN PARSONS.

Croydon, February 1.

WITH reference to the letters by Messrs. Evershed and Fermor in NATURE of January 30, it may be of interest that an amusing description of the appearance of halos around shadows is given by Benvenuto Cellini in his autobiography (book i., chap. cxxviii.). After being released from a well-deserved term of imprisonment, he noticed a halo round the shadow of his head, and interpreted it as a mark of the especial favour of heaven. A rough translation of the passage is as follows:—"Also I must not leave unmentioned a thing, the greatest that has happened to any man, which I tell to the glory of God and of His mysteries, who condescended to make me worthy of it. From that time . . . there remained a splendour (wondrous thing!) on my head, which is evident to all sorts of men to whom I have shown it (who have been very few). This is seen over my shadow in the morning from sunrise until two hours later, and is seen much better when the grass has dew upon it; it is visible again at sunset. I became aware of it in France at Paris, because the air there is so much more free from mist that one sees it more markedly than in Italy, where mists are more frequent."

Doubtless the "pochissimi" to whom he showed it knew him too well to confess that they saw the halo around the shadows of their own heads, not his.

I have often noticed the appearance, especially on short turf, such as that of golf links, when the grass is wet with dew, but it may sometimes be seen on dry grass.

L. DONCASTER.

Museum of Zoology, Cambridge, February 1.

Flowers in January.

SEVERAL interesting letters have recently appeared in these columns directing attention to the abnormal number of phanerogams in flower at the present time in Gloucestershire and other counties. In Somerset we have a similar increase in the number of plants flowering, as compared with the average January, and this month is not the only winter one in which such an increase has occurred. During the latter part of November I noticed more than eighty indigenous plants in flower, and many of these I considered to be survivals due to the retarding influence of the cold and wet summer followed by the cold and frosty nights of October. For the past two years the paucity of flowers in the early part of October has been particularly noticeable, but how different were the causes! In 1911 the flowering period had been accelerated by the large amount of sunshine, whilst in 1912 it was retarded or altogether eliminated owing to the lack of sunshine. In both years November was a happy month for flowers, in the first year the flowers being largely second blooms, in the last year retarded first blooms.

The acceleration of the life-cycle is also noticeable to a student of the lower forms of vegetation, some mosses, liverworts, and lichens showing a similar advance in the time of spore-production. For instance, amongst the mosses *Encalypta vulgaris* has well-developed capsules, and amongst the liverworts *Lophocolea cuspidata* is already shedding its spores, these phases of the life-cycle being one to three months earlier than the normal time. No doubt, in the case of these and many other accelerated cryptogams, the wet weather is as potent a factor in the acceleration of the life-cycle as the mildness of the season.

W. WATSON.

Taunton School, Taunton, Somerset.

The Current Winter.

A FEW years ago (in 1908) I expressed in your columns two views about the Greenwich winter, which both appear to gain further support from what is now happening. One is that after a very wet Rothesay summer, the Greenwich winter tends to be mild (NATURE, March 12, 1908, p. 438), the other that after an autumn at Greenwich with all three months dry, the Greenwich winter tends to be mild (NATURE, December 24, 1908, p. 221). We have both those antecedents in 1912—that is, the Rothesay summer was very wet, and the three months September–November at Greenwich were all dry—and the current winter may now be safely characterised as mild.

ALEX. B. MACDOWALL.

Torquay, January 25.

MATERIAL FOR THE HISTORY OF MAN AND BEAST.[1]

IT is easy to understand why Weimar was chosen as the meeting-place of the German Anthropological Society in 1912. The surrounding country is rich in remains of man of the Pleistocene and prehistoric periods; the municipal museum contains the fauna and flora of celebrated palæolithic stations such as Taubach, Suessenborn and Ehringsdorf; in this museum, also, can be seen one of the best collections in Europe for illustrating the evolution of prehistoric culture.

The three memoirs reviewed here were prepared to give the members of the Anthropological Society a just conception of the prehistoric treasures preserved at Weimar, but it must not be supposed that they will serve only a passing purpose. Far from it; each memoir is a valuable contribution to the department of knowledge to which it belongs. Dr. Ludwig Pfeiffer, well known to the medical men of Europe as a physician, writes on the evolution of human handiwork from the Pliocene to the present, employing the collections in the Weimar Museum to illustrate his memoir. Dr. Soergel deals with the greater mammals which became extinct during the Pleistocene period. Dr. Moeller, curator of the Weimar Museum, gives an account of the systematic exploration of one of the most remarkable tumuli ever opened. The subject-matter of all three memoirs is thus illustrated by the contents of the Museum of Weimar; Dr. Soergel's paper covers the Pleistocene epoch; Dr. Möller's deals with

[1] Festschrift zur xliii. allgemeinen Versammlung der Deutschen Anthropologischen Gesellschaft, Weimar, 4 bis 8 August, 1912. Erstes Heft. Die steinzeitliche Technik und ihre Beziehungen zur Gegenwart. By Dr. Ludwig Pfeiffer. Pp. vii+340. Price 13 marks.

Zweites Heft. Das Aussterben diluvialer Säugetiere und die Jagd des diluvialen Menschen. By Dr. W. Soergel. Pp. iii+81+3 plates. Price 5 marks.

Drittes Heft. Der Derfflinger Hügel bei Kalbsrieth (Grossherzogtum Sachsen). By Armin Möller. Pp. ii+76+4 plates. Price 5.40 marks. (Jena: Gustav Fischer, 1912.)

mankind in central Germany in post-Pleistocene times; Dr. Pfeiffer's inquiry covers both periods.

The tumulus explored by Dr. Möller (he had great difficulty in obtaining permission to undertake the work) lies about twenty miles north of Weimar, on a slight elevation among the flat fields which border the Unstrut—a tributary of the Saale. Interments were discovered which date from the early part of the Neolithic period down to mediæval times—roughly speaking, from 3–4000 B.C. to 1000 A.D. A section of the tumulus—oval in shape and measuring 30 metres in its longest diameter—revealed within it a small tumulus, covering a single interment, of the early Neolithic period. On the southern margin of the smaller and older tumulus were three intrusive burials—in the contracted posture—also Neolithic in date. At the southern base of the tumulus, at a still later Neolithic date, there had been placed a cyst, or slab tomb, flanked with altar floors. The larger tumulus, which covers the older and smaller one, had been thrown up over a fourth interment, a cyst burial, covered with a cairn of stones, which is ascribed to the close of the Neolithic period.

These four burials of the Neolithic period were accompanied by such evidence that their sequence and date could be determined with a fair degree of accuracy. The Bronze period is represented by only one interment, the body having been entombed within a dug-out canoe. The pre-Christian period was represented by three urn-burials; the tomb of a warrior of the fifth or sixth century marked the Merovingian age; lastly, numerous graves of people buried in early Christian times (ninth and tenth centuries) occurred all over the large tumulus. Dr. Möller's attention was more particularly directed to the pottery and other accompanying evidences of civilisation, which gave him a clue to the dates of the various interments. The skeletal remains of the men, women, and children buried in the tumulus, often reduced to little more than dust, are only incidentally touched upon. It will be thus seen that, in expert hands, tumuli become the most valuable of prehistoric documents

In Dr. Soergel's memoir a most useful contribution is made to the systematisation of our knowledge of the larger mammals which became extinct towards the end of the Pleistocene period. Every palæontologist has observed that the extinction of these great animals is coincident with the progress and distribution of human races in the Pleistocene period. Indeed, Dr. Steinmann (*Die geologischen Grundlagen der Abstammungslehre*, 1908) came to the conclusion that their extinction took place at the hands of man. Dr. Soergel does not agree with that view; he holds that the frequent changes of climate in the Pleistocene epoch led to a manifestation of a high degree of variability amongst certain of the mammalian genera, and that the forms which became most highly specialised—such as the Irish elk—in contradistinction to the less specialised form—*Cervus dama*—became extinct because of their highly specialised characters. An unprejudiced survey of the evidence inclines the reviewer to regard Dr. Steinmann's conclusion as the nearer approximation to the truth.

Dr. Pfeiffer's memoir—by far the more important of the three—is an honest attempt to lay archæology, so far as it is concerned in investigating the evolution and history of human handicraft, on a firm foundation. His work is beautifully illustrated, and he has spared no pains to obtain evidence by experiment and by direct observation. The scope of his memoir will be best indicated by giving the titles of its seven chapters: i., the technique employed in fashioning stone implements during the periods of stone; ii., the physical conditions determining the various forms of technique employed; iii., various forms of fashioned stones; iv., the bone implements of the Stone periods; v., wood implements of the Stone periods; vi., the utilisation of the products of the chase; vii., the extinction of the industries of the Stone periods. Dr. Pfeiffer does not touch on the evidence of a high surgical technique amongst the people of the Neolithic period. The ancient skulls with clear signs on them of extensive operations and limb-bones with well-healed fractures show that there were daring and successful surgeons amongst the Europeans of the Neolithic period.

THE PASTEURISATION OF MILK.

IN a former article on "Tuberculosis and the Milk Supply" (NATURE, November 7, 1912, p. 281), reference was made to pasteurisation as one of the means suggested for the provision of a pure milk supply.

Pasteurisation, as applied to milk, is a process of somewhat indeterminate nature. It denotes the heating of milk to a temperature which may range between 140° F. and 165° F. in "bulk" pasteurisers, in which the milk remains, and is maintained at the temperature employed during the whole period of treatment—some 20–30 minutes—or up to 180° F. in "flash" pasteurisers, in which the milk flows continuously through the apparatus and the period of heating is a brief one. In both cases the milk is immediately run on to coolers. Either method fulfils more or less completely the objects for which pasteurisation is carried out, which are (1) to destroy pathogenic micro-organisms, such as tubercle, typhoid, and diphtheria, that may have gained access to the milk; (2) to reduce the bacterial content of the milk, and, as a consequence, (3) to enhance the keeping qualities of the milk, and to allow its distribution in a merchantable condition. The treatment undoubtedly effects these objects more or less efficiently, but it remains to consider in what manner the after-condition of the milk may be influenced thereby.

By heating milk above a temperature of 165° F. a more or less rapid destruction of the lactic-acid-producing organisms occurs, while the more resistant putrefactive forms largely survive the treatment, and it is owing to this change in the bacterial flora that danger arises should the milk subsequently be kept at temperatures favourable to bacterial growth and development. It is true that Ayres and Johnson have stated, as a result of their experiments on milk pasteurised at 145° F. for 30 minutes or at 160° F. "flash," that the resultant milk sours similarly to raw milk, and that the relative numbers of the various organisms remain unchanged.

Apart from the fact that these temperatures are probably untrustworthy for killing the tubercle bacillus, it is necessary to point out that, though the relative proportions of the organisms may be unaltered by this treatment, it by no means follows that the actual species remain the same, for the predominant lactic-acid organism (*Streptococcus lacticus* or *Güntheri*) certainly succumbs at these temperatures. In any event, the subsequent bacterial content of pasteurised milk depends not only on the pasteurising temperature, but also on the temperature at which it is subsequently kept. Milk pasteurised at a temperature above 165° F. for any time, and afterwards kept at a temperature above 65° F., always undergoes what may be termed a "peptolytic" change, allied to putrefaction, and the latter may actually occur if pasteurisation has been conducted at 170°–175° F.

With pasteurisation at these higher temperatures, this "peptolytic" change may take place without at first apparent alteration in the milk. These changes, however, do not take place if the milk, after pasteurisation, be kept below 50° F., and this is the crux of the matter so far as the bacterial content is concerned. The real danger of pasteurised milk arises from the fact that the milk is stored by the consumer in warm pantries, or is purposely kept hot in vacuum flasks or food-warmers for infant or invalid feeding! A similar danger may ensue if, as is frequently done, the milk be boiled and allowed to cool spontaneously. It is notorious that summer diarrhœa in children coincides with the period when room-temperatures of 70° F. and upwards prevail, and when the necessity for boiling the milk is considered to be greatest, the proper cooling and protection of such boiled milk being completely overlooked and omitted! The work of Dr. Ralph Vincent in this connection is strongly confirmative of this view.

There can be no doubt that summer diarrhœa of children is not due to an excessive development of the true lactic-acid-producers, for the administration of soured milk or whey is often of service in the treatment of the condition, and soured milk containing vast numbers of these organisms is a valued article of diet in all parts of the world, including the tropics. When summer diarrhœa occurs after the use of raw uncooked milk, the explanation is that an initially dirty milk has been kept at such a temperature that the peptolytic bacteria have developed more vigorously than the lactic forms, and these organisms or their products induce the condition.

If raw and pasteurised milks be kept at blood-heat until curdling ensues, the character of the curd and the microscopical appearances therein will be found to be entirely different, despite the fact that, even in the raw-milk sample, considerable proteolysis (though from a different cause) may have taken place.

If, then, pasteurised milk is to be taken in preference to raw milk, unless consumed at once there seems to be only two ways of safeguarding its use, either (1) to cool immediately and subsequently to keep it always at a temperature below 50° F., which in summer in the household is difficult to ensure, or (2) to add a sufficiency of an active culture of lactic-acid-producing organisms to reproduce the original condition of the raw milk, which may not be altogether practicable. Similar considerations affect the use of boiled milk. Unless safeguarded, pasteurisation may also lead to less care in the production and distribution of the milk, since obvious change in it occurs more slowly than in untreated milk. There will also be a tendency for the smaller and the less scrupulous dealers to treat dirty or returned milk, and thus to make sure of its ultimate disposal.

There is no need here to enter into the vexed question of the alteration and diminution in nutritive qualities which ensue from heating milk. The lower the temperature of heating the less the alteration, and in this respect pasteurised milk has the advantage over boiled or sterilised milk.

R. T. Hewlett.

NOTES.

We announce with regret the death on January 31, at sixty-five years of age, of the Earl of Crawford, F.R.S., president of the Royal Astronomical Society in 1878–79, and distinguished in the world of science by his work for astronomy.

A Reuter telegram from Stockholm announces the death, at sixty-seven years of age, of Dr. G. de Laval, the well-known inventor of the steam turbine which bears his name.

Dr. W. Carter, who for many years was professor of materia medica and therapeutics in the University of Liverpool, and took a large share in the initiation of the Liverpool School of Tropical Medicine, died on February 2 in his seventy-seventh year.

At the annual general meeting of the Royal Astronomical Society, to be held on Friday, February 14, the gold medal of the society will be awarded to M. H. A. Deslandres, for his investigations of solar phenomena and other spectroscopic work, and the Jackson-Gwilt medal and gift to the Rev. T. H. E. C. Espin, for his observations of the spectra of stars and his discovery of Nova Lacertæ.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, on Thursday and Friday, May 1 and 2. The Bessemer gold medal will be awarded to Mr. Adolphe Greiner, general director of the Société Cockerill, Seraing, vice-president of the institute. The autumn meeting will be held at Brussels, at a date to be announced later.

With the current number, the second volume of the Bulletin of the Seismological Society of America is completed. The notes, which we have given from time to time, are some indication of the useful work carried on by the society, which now includes 375 members. The recent number contains a portrait and short memoir of Comte de Montessus de Ballore, the director of the Chilean earthquake service.

The Board of Agriculture and Fisheries announces that, in conjunction with the economic ornithological committee of the British Association, it is engaged on an inquiry into the food of birds, especially those believed to be injurious to farmers and fruit-growers. Investigations are at present confined to the rook, the starling, and the chaffinch. The Board would be glad to receive the names of correspondents who are willing to send to an address which will be supplied them, specimens of one or more of these birds at regular intervals during the year. Correspondents are wanted from all counties in England and Wales.

The death is announced of Dr. J. F. J. Sykes (medical officer of health of St. Pancras, London) in his sixtieth year. From an obituary notice in *The Times* we learn that for some years Dr. Sykes was an assistant examiner in hygiene to the Science and Art Department, and did a great deal for the improvement of public health in London. The Royal Statistical Society awarded him the Howard medal in 1900; he was Milroy lecturer of the Royal College of Physicians in 1901, member of the council of the Royal Sanitary Institute, president of the Society of Medical Officers of Health, and a member of various foreign societies of hygiene.

A circular has reached us referring to an exhibition of interesting scientific objects and apparatus to be held at the Assembly Rooms, Surbiton, on February 19–22. In the list of exhibits we notice stellar photographs, photomicrographs, wireless telegraphy and telephony, the microphone, liquid air, the spectroscope, Lissajous's figures, Chladni's plates, singing flames, the spinthariscope, flint implements, many microscopes, with objects in the fields of view, and other things of scientific interest. Fifty years ago or more—in the days of Prof. Pepper and his optical illusions—such exhibitions as that to be held at Surbiton were common, and it is to be regretted that they are not now held more frequently. We hope the success of this exhibition will be sufficient to encourage the promoters to continue the exhibition at other places.

By the death of Prof. Robert Collett, of Christiania, Europe has lost one of its leading vertebrate zoologists of the older school. His work on the mammals and birds of Norway was always sound and accurate, and its value is little, if at all, impaired by the fact that he seems never to have quite reconciled himself to the rules of nomenclature as evolved by the modern systematist. He had just completed his *magnum opus*, his "Mammals of Norway," wherein are summarised the study and observations of a long life devoted to the zoology of the mammals of his country. Europe, and the whole zoological world, are to be congratulated that he was spared to complete the above work, which must remain for a very long time the chief authority on the mammals of Norway, and is besides indispensable to students of the order in other countries.

The friends of the late Mr. H. O. Jones, F.R.S., who with his wife met his death in such tragic circumstances last summer in the Alps, are of opinion that some permanent memorial to him should be established in the University of Cambridge. There is at present no teaching post especially associated with physical chemistry in the University, and as the laboratory now affords opportunity for study and research in this modern branch of chemistry, the committee appointed for the purpose of the memorial recommends that the endowment of such a post in connection with physical chemistry would form an appropriate and a lasting memorial to Mr. Jones, and one calculated to further a cause in which he was peculiarly interested. Subscriptions towards this appropriate form of memorial to Mr. Jones may be paid to either of the hon. treasurers, Mr. W. L. Mollison, Clare College, Mr. R. Waley Cohen, 11 Sussex Square, London, W., or to the Humphrey Owen Jones Memorial Fund, c/o Messrs. Barclay and Co., Cambridge Branch. Subscriptions to the extent of more than 2750*l.* have already been received.

The present winter is proving exceptionally mild over the whole of the British Isles, and the midland and eastern districts of England have as yet experienced the greatest excess of temperature, whilst they have had a rainfall about half as much again as the normal. The mean temperature at Greenwich for January is 41·3°, which is nearly 3° in excess of the average, whilst in January last year the mean was 40·4°. The higher temperature this year is almost wholly due to an excess in the maximum or day readings. January this year had nine frosts against eight in the corresponding month last year; open to the sky there were twenty-one frosts this year and nineteen last year. The rainfall in January this year at Greenwich is 2·67 in., which is 0·74 in. more than the average, but 0·36 in. less than in January last year. In the London districts there was an excess of sunshine in January this year, the duration at Greenwich being fifty-six hours, which is ten hours more than the average of the last ten years, and twenty-two hours more than the average of the last thirty years. In January, 1912, the duration of sunshine at Greenwich was only twenty-eight hours. At Kew the duration of sunshine this January is forty-one hours, against 20·5 hours last year, and in the City, at Bunhill Row, the duration of sunshine this January is 13·5 hours, and was only eight hours in January last year. The rainfall for January is in excess of the average in all parts of the British Isles except in the north of Scotland; the greatest excess is in Ireland and in the southern and midland districts of England. The duration of bright sunshine for the past month is below the average in all districts of the United Kingdom except in the south-east of England, but the deficiency is only 0·2 hour per day in the north of Scotland and in the north-west of England. In the east of Scotland and in the midland counties the deficiency is 0·6 hour per day.

PROF. H. E. JORDAN, in a paper entitled "Studies in Human Heredity" (University of Virginia Publications, Scientific series, i., 12, 1912) gives a number of pedigrees showing hereditary transmission of human abnormalities and diseases. The pedigrees are mostly small, and are suggestive rather than final. The greater number deal with left-handedness, a condition which usually appears to be recessive, although some pedigrees suggest that it may behave as a dominant. Of the several other abnormal conditions dealt with, including cancer, hermaphroditism, nephritis, and others, perhaps the most important is the tendency to tuberculosis, which the author discusses more fully in the Journal of the American Medical Association, lix., 1912, p. 1518. He gives pedigrees showing hereditary transmission through several generations, and refers to previous evidence of the importance of heredity in this disease. He appeals especially to the medical profession for the careful collection of further data, and points out the danger from the marriage of consumptives if, as he believes, inheritance plays a predominant part in predisposing to the disease.

THE paper on Morocco recently read before the Royal Geographical Society by Mr. A. G. Ogilvie afforded interesting examples of the application of theories of geographical control, in this way—that as Morocco is a country about which there exists relatively slight knowledge of geographical detail, it is necessary to add deduction to description in order to arrive at a fair general account. For example, rainfall observations are of the scantiest, but the author put forward a map of the probable distribution of rainfall based partly on the distribution of types of vegetation, as well as on a consideration of the relief of the land and the prevalent winds. From this he was able to pass on to a discussion of those areas which are most suitable for agriculture—not merely those which are cultivated, but also those which might be. He added Morocco to the list of potential granaries of the world, and mentioned the possibility of applying the principles of dry-farming in the interior steppes of the Meseta. Reference was also made to the alluvial fans at the foothills of the Atlas, highly fertile, and even now freely irrigated by the Berber inhabitants, through covered channels which guard against evaporation. These are only a few examples of a number of points of interest in the paper.

IN the January number of *The Zoologist* Mr. E. A. Smith states that Lord Denbigh has presented to the British Museum (Natural History) the collection of natural history objects made by Thomas Pennant, the author of "British Zoology," which has remained in a more or less undisturbed condition since the death of the original owner at Douning Hall, Holywell, Flintshire, on December 16, 1798. The collection chiefly consists of stuffed birds, shells, fossils, and minerals, but also includes a few mammals, fishes, and crustaceans. Among the recent shells fifteen types and sixty-one specimens figured in the "British Zoology" have been identified.

ACCORDING to the report for 1911–12, the Natural History Society of Northumberland, Durham, and Newcastle has taken steps to increase the educational use of its museum by an arrangement with the Newcastle Education Committee. As a result of this certain classes of scholars have been admitted to receive a course of lectures, chiefly on the British vertebrate fauna. During the year the society acquired the carcase of a rorqual (*Balaenoptera borealis*) measuring 45 ft. in length, of which the skeleton is being prepared for exhibition. The weight of the flesh removed is stated to have been 15 tons, and that of the skull half a ton; it would be interesting to know whether this is an exact statement or merely a rough estimate.

THE investigations of the black cotton soils of India have been carried a stage further by Messrs. Harrison and Sivan in the Memoirs of the Agricultural Research Institute, Pusa (No. 5). Previous investigators had shown that in certain areas titaniferous magnetite occurred to the extent of several per cent., and they therefore attributed the black colour to this substance. The present authors show that in other parts of India similar soils occur, but do not contain titaniferous magnetite, and they adduce reasons for supposing that in these cases the colour is associated with the compound particles of relatively small dimensions. They consider that the black material is a colloidal silicate of iron and aluminium, containing also organic matter.

MR. R. C. MCLEAN has recently described (*New Phytologist*, 1912, No. 8) two fossil prothalli from the Lower Coal Measures, one belonging to the Pteridospermic seed, *Lagenostoma Lomaxii*, the other to some member of the Lepidodendron family. There are very few examples of fossil prothalli preserved from the Palæozoic formations, and among the few a good state of preservation is decidedly rare. In the Lagenostoma prothallus, displaying in excellent preservation a structure hitherto unrecorded for this well-known plant, the arrangement of the tissue resembles that found in the prothalli of recent Gymnosperms, and this strengthens the view that the latter have arisen from an ancestral type characterised by the possession of a pollen chamber. The second prothallus, showing exquisite preservation, had developed outside the spore after the latter had been shed, and it remained attached to the spore-wall at its base, resembling in general form the prothalli of modern heterosporous ferns like Salvinia. Assuming that this specimen is referable to the Lepidodendroid genus Bothrodendron, the prothallus of this genus was more primitive than that of Lepidodendron, where the archegonia developed inside the spore.

To the first volume of the *Fortschritte der Mineralogie, Kristallographie und Petrographie*, issued under the auspices of the recently founded German Mineralogical Society, Prof. Berwerth contributes a valuable memoir on the progress made in the study of meteorites since 1900, in which he gives, besides lists of the literature published and of the falls or discoveries of meteorites made during the decade, and full particulars of chemical analyses, interesting articles on such important questions as the origin of meteorites, their form and surfaces, &c.

Among various items of useful information included in the United States Meteorological Charts for February, we may specially mention an account of three recent Pacific volcanic eruptions, by Prof. McAdie, with concomitant atmospheric phenomena and illustrations, viz.: (1) at Taal, Luzon, January 30, 1911; (2) at Asama-yama, Japan, May 8, 1911; and (3) at Mount Katmai, Alaska, June 6, 1912. Although these occurrences have already been reported in the publications of the respective countries, it may be of interest to general readers to be able to refer to them in one periodical. The chart in question can presumably be easily obtained from the Washington Weather Bureau, or from American Consular offices at important seaports abroad. The volcano at Katmai was supposed to be extinct, but eruptions have taken place in several months subsequent to June.

Compared with the neighbouring islands of Japan, the peninsula of Korea is singularly free from earthquakes. The records contained in the old chronicles of the country extend back, however, for nearly two thousand years, the first known earthquake having occurred in the year 57 B.C. These and other records have recently been examined by Dr. Y. Wada, the director of the Meteorological Observatory of Chemulpo (Scien. Mems. of the Met. Obs. of the Government-General of Korea, vol. ii.). The total number of earthquakes in the period mentioned amounts to 1671, of which fifty-nine were notable shocks, many of them having attained a strength sufficient to damage buildings, and several to result in loss of life. Dr. Wada gives an interesting map of what he calls the seismic density of the different parts of the country. North of the parallel of 37° N., the seismic density decreases almost uniformly from west to east, while south of that parallel, that is, in the part of the country facing Japan, there is a rapid decrease in density from east to west.

A remarkable difference exists between the climates of western and central Japan, so much so that these districts are distinguished by the two names Sanindō (shady side) and Sanyōdō (sunny side) respectively. During the long and rigorous winter of western Japan, the central provinces, bordering the Inland Sea, enjoy dry and comparatively mild weather. The two regions are separated by mountain ranges, and the factors determining their climatic conditions are distinct. In the Journal of the Meteorological Society of Japan (xxxi., No. 9, 1912), Mr. G. Ishida gives the results of some elaborate investigations carried out by others and himself in this connection. He finds that while the winter climate of central and southern Japan depends on the south-western monsoons, that of the western coast is directly related to the barometric area of North China. Records of the mean daily temperature at Tientsin, representing the continental area, for a period of six years from 1904–5 to 1910–11, comprising the eight months from September to April in each case, were collated with corresponding records taken at Hamada and Sakai, representing western Japan. The diurnal variations at Tientsin for each month in the whole period of six years, ranging from 169 days for February to 186 days for December, were obtained and compared with those recorded at the Japanese stations respectively on the same day, and one, two, and three days later. The results indicate a striking similarity between the winter temperatures of North China and western Japan, especially as regards the records taken at an interval of two days between the two areas.

The *Eugenics Review* for January contains a report of the research committee of the Eugenics Education Society regarding the standardisation of the notation used in drawing up pedigrees. Among various features of the committee's recommendations we note use of squares and circles to denote male and female offspring, arrangement of children in order of age, darkening of the whole or part of the circle or square to denote presence or absence of any special characteristic which it is desired to record, and the use of certain letters to denote age of death, death by suicide, or other particulars.

Prof. F. Y. Edgeworth's presidential address to the Royal Statistical Society, published in the Journal of the society for January, deals with the use of probabilities in statistics relating to society. In this address Prof. Edgeworth draws an analogy between the phenomena exhibited by a medium of gas molecules and a collection of individuals, and argues that as the doctrine of probabilities enables definite laws to be established according to the kinetic theory of gases, similar laws may be built up regarding social phenomena. Although Prof. Edgeworth does not actually use this term, it may be possibly suggested that the analogy is due to both groups being in the language of Boltzmann, "molekular ungeordnet."

The method in use at the Reichsanstalt for the testing of magnetic materials with high-frequency currents is described by Drs. H. Fassbender and E. Hupka in vol. vi. of the *Jahrbuch der drahtlosen Telegraphie und Telephonie*. The wire tested is in the form of a ring, and is magnetised by the high-frequency currents from a Poulsen arc. The values of the magnetising field and the rate of change of the resulting magnetic induction are obtained by means of the electrostatic deflections of the kathode rays of a Braun tube, the two deflections being at right angles to each other. A complete hysteresis curve is obtained from the loop on the screen at the end of the tube. Of the various suggestions as to the quantity which should be adopted as the measure of the dynamical permeability, the authors find the best to be the quotient of the maximum induction by the maximum field.

We have received a copy of the reprint of Dr. M. Jakob's paper on the specific heat and specific volume of steam for pressures up to twenty atmospheres and temperatures up to 550° C., which appeared in the *Zeitschrift* of the Association of German Engineers last year. The work is based on the experimental determinations of the specific heat of steam made by Knoblauch and Jakob and by Knoblauch and Mollier. From these values the author, by a graphical method which solves the thermodynamic equation connecting the rate of increase with pressure of the specific heat at constant pressure with the rate of increase of the expansion with temperature, determines the specific volume over the range stated in the title of his paper. Up to eleven atmospheres and 190° C. the calculated values agree closely with the observations of Linde, so that it seems probable that they may be trusted over the much wider range covered by the author.

THE second lecture on chemistry in gasworks, arranged by the Institute of Chemistry, was delivered by Mr. W. J. A. Butterfield, on January 31, at University College. Mr. Butterfield showed that the sensitiveness of lead acetate paper as a test for the presence of sulphuretted hydrogen varies inversely with the area of the paper exposed to the gas. The sulphur impurity remaining in gas after the extraction of sulphuretted hydrogen, he considers to be objectionable on account of its destructive action on the metalwork of inverted burners and fittings directly exposed to the undiluted products of combustion of gas. In connection with the by-products of gas manufacture, he stated that the predominant uses of tar at present are for the production of pitch for the supply of the patent-fuel industry of South Wales, and for road construction and treatment. Physical tests of tar and pitch are misleading as to the value of these materials for the latter purpose, because the physical characteristics change with efflux of time, and the extent and bearing of the changes which thus occur in tar and pitch can be ascertained only by appropriate chemical examination of them. Mr. Butterfield directed attention to the acceptance practically everywhere, except in German-speaking countries, of the Harcourt 10-c.p. pentane lamp as the reference standard of light for all photometric work. The secondary electric standard lamps are calibrated by comparison with it Comparative tests have been made of the light afforded by about 150 different specimens of the Harcourt 10-c.p. lamp, and a disagreement by more than 0·2 per cent. has never been found, except in cases where there has been a fault in construction.

AT the sixth congress of the International Association for Testing Materials, held in New York last September, fifteen papers were submitted dealing with impact and endurance tests. These are summarised by Dr. W. Rosenhain in *The Engineer* for January 31. In drawing conclusions, Dr. Rosenhain states that the general feeling at the congress was not in favour of introducing impact tests into specifications as yet. While enough has been done to show that some form of impact test is desirable, there is a lack of consistent results from different machines and different forms of test pieces. It is evident that what is now required is carefully directed research by many independent workers with the view of clearing up the causes of discrepancies. Further progress in mechanical testing by dynamic methods should be sought by simplifying the test conditions as much as possible, and by arranging the experiments in such a way as to isolate and measure one single physical property or constant of the material, rather than by any attempt to imitate in the laboratory the complex conditions of practical use.

A COPY of the Almanac of the Egyptian Government for 1913 has been received. In addition to full particulars of the various Government departments, the Almanac contains valuable meteorological, magnetic, and other scientific data.

A COPY has been received of a new, revised, and enlarged edition of the pamphlet published in 1908 by Ilford, Ltd., giving notes on the Ilford X-ray plates. Scientific workers desiring to possess copies of the pamphlet, which is effectively illustrated, may obtain them, free of charge, on application to the company at Ilford.

OUR ASTRONOMICAL COLUMN.

COMET 1912*a* (GALE).—Gale's comet, discovered in September last, is now a circumpolar object, of about the tenth magnitude, in our latitudes. From the following ephemeris, abstracted from a daily ephemeris published by Dr. Ebell in No. 4627 of the *Astronomische Nachrichten*, it will be seen that the comet is now travelling southwards through Cassiopeia, and may be observed high up in the west during the evening.

Ephemeris 12h. M.T. Berlin.

1913	α (h. m.)	δ (° ′)	1913	α (h. m.)	δ (° ′)
Feb. 7 ...	3 15·1 ...	+78 45	Feb. 19 ...	4 17·2 .	+71 56·2
11 ..	3 42·1 ...	+76 24	23 ...	4 29·9 ...	+69 51·7
15 ...	4 1·8 ...	+74 7	27 ...	4 40·6 ...	+67 54·3

Observed by Herr G. van Biesbroeck at Uccle between January 4 and 9, the magnitude of the whole comet was about 9·0, and the diameter, observed in a finder, was about 10′. In No. 4625 of the *Astronomische Nachrichten*, Herr Moschonkin directs attention to the similarity between the elements for Gale's comet and those for a comet which appeared in 1672.

THE EXPECTED RETURN OF FINLAY'S SHORT-PERIOD COMET.—With a period of 6·5 years, the comet discovered by Finlay at the Cape in 1886 is shortly due at perihelion. According to elements previously calculated by M. Schulof, perihelion passage should take place on March 24, but the comet passed very near to Jupiter in the summer of 1910, and, from a study of the perturbations, M. G. Fayet finds that perihelion has probably been advanced by about six weeks. His new elements, published in No. 4626 of the *Astronomische Nachrichten*, give February 6 as the date and he gives three search-ephemerides based on the assumptions that perihelion would be passed on February 6, January 29, and February 14 respectively. The first gives the present position as lying in Aquarius very near the western horizon at sunset. At no time during this apparition will the comet be an easy object, chiefly owing to its apparent proximity to the sun, but it may be rediscovered by means of one of the powerful instruments now available; during February the theoretical brightness is about that at the time of the comet's discovery.

THE MAGNITUDE VARIATIONS OF NOVA GEMINORUM No. 2.—A large number of observations, made at several observatories, of the magnitudes of Nova Geminorum No. 2, are published in No. 4624 of the *Astronomische Nachrichten.* In addition to the tables giving the magnitudes recorded at the Berlin Observatory, Herr Freundlich publishes a light-curve showing the variations of the nova's magnitude from March 14 to May 18, 1912. This curve agrees fairly well with that previously published by Herr Fischer-Petersen, and shows maxima, successively decreasing in intensity, on March 14, 23, April 3, 19, and May 1.

POSSIBLE CHANGES OF A LUNAR FEATURE.—In the January number of *L'Astronomie,* M. Pierre Stoïan directs the attention of lunar observers to a small "hill" which, according to his observations, undergoes changes of form and size. This small feature lies to the north of the line joining Thebit and Birt, and about half-way between the former and the small crater at the northern end of the Straight Wall. M. Stoïan points out that Nasmyth recorded nothing in this position, Neison saw a double peak, and the Paris photographs show a crescent-shaped eminence which to Gaudibert was an oval; others have recorded it as larger than the smaller of the two small craters in the N.E. wall of Thebit, while to some observers it has appeared to be smaller. The feature appears to be worth further attention on the part of selenographers.

PHOTOGRAPHIC TRANSIT OBSERVATIONS.—By the munificence of Messrs. Krupp, Prof. Ambronn was able to secure a photographic transit apparatus for use at the Göttingen Observatory in the early part of 1911. The instrument has been tested and used by Herr R. Trümpler, who describes it and the results secured in No. 4620 of the *Astronomische Nachrichten.* The focal length of the Göttingen instrument is 180 cm., the aperture 18 cm., and photographic transits of stars down to the eighth magnitude may be secured. A slight relative displacement every second results in the photographic trace of each star being a wavy line, each minute being especially marked; the images of the transit-threads are also impressed upon the plate, so that any plate may be measured or re-measured at leisure, the time of starting the exposure having been recorded. The excellence of the images is shown by a plate accompanying the paper, and a comparison of Herr Trümpler's with other results promises well for the photographic recording of star transits.

THE MARINE BIOLOGICAL STATION AT PORT ERIN.

THE twenty-sixth annual report of the Liverpool Marine Biology Committee gives evidence of the rapidly increasing importance of the laboratory at Port Erin as a centre for research and for the instruction of students. The number of workers has more than doubled during the last six years; there were seventy-four workers during the year 1912. The extension effected two years ago has been fully occupied, and the director (Prof. Herdman) reports that already further accommodation for research is urgently required.

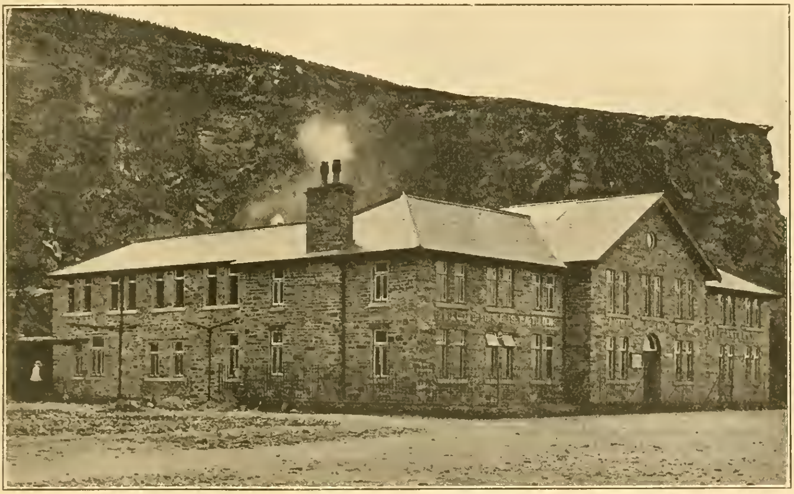

FIG. 1.—The Port Erin Biological Station from the north-east.

Among noteworthy matters mentioned in the report are the weekly lessons and demonstrations given by the curator (Mr. H. C. Chadwick) to the boys from the local secondary school.

Prof. B. Moore and his colleagues are carrying out an extensive physiological and chemical investigation into the nutrition and metabolism of marine organisms. The results show that the amount of organic carbon present in the sea-water is almost negligible, being well below one milligramme per litre of water, and that Pütter's estimates are incorrect. They also show that, while the plankton-supply, as found generally distributed, may prove sufficient for the nutrition of such sedentary animals as sponges and ascidians, it is quite inadequate for active animals, such as crustaceans, molluscs, and fishes. These latter, however, are able to seek out their food, and are not dependent only upon what they may filter from the sea-water. The investigation has also brought to light a notable change in the reactions of sea-water at different seasons of the year, no doubt in correlation with the development of vast quantities of plankton-organisms.

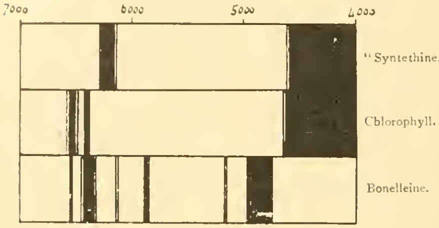

FIG. 2.—Absorption bands of pigments.

In spring (April) the water, not only near the shore but in the open sea, is acid to phenolphthalein, while in summer (August) it is distinctly alkaline to the same indicator, a change which signifies an enormous conversion of carbon in the inorganic into carbon in the organic form.

Prof. Moore, Dr. Adams, and others have studied the chemical changes taking place in the reproductive organs of the sea-urchin. They have found that, under normal conditions of nutrition, the amount of food consumed by a sea-urchin is many times that required for the ordinary metabolic uses of the animal. The excess is converted into storage products—glycogen, lecithides, and fats—which, throughout the non-breeding period, accumulate in the reproductive organs in quantities as great as are usually found in the liver or hepato-pancreas of other animals, and form a reserve for use during the breeding season.

Prof. Herdman has continued his observations on the occurrence of the dinoflagellate Amphidinium on the beach at Port Erin, and records certain variations in the form of this organism, and the alternate appearance in the same area, during the early part of the year, of Amphidinium and of diatoms (*cf.* NATURE, November 28, 1912, p. 371).

Prof. Herdman and his assistants have collected and examined, during 1912, about 400 samples of plankton from Port Erin and the neighbourhood. These show that diatoms, dinoflagellates, and copepods succeed each other in the summer plankton of the Irish Sea. The autumnal phyto-plankton increase was greater than usual in 1912, immense numbers of diatoms, chiefly Chætoceras, being present in the latter part of September. Plankton gatherings were also made along the chain of the Outer Hebrides, and proved to be oceanic in character.

During this Hebridean cruise, specimens of the ascidian *Syntethys hebridicus* were dredged. They were pale green when alive, but when placed in spirit became mauve or violet in colour. The colour is due to a new pigment, syntethine, the absorption-bands of which differ from those of chlorophyll and bonelleine (see Fig. 2).

NOTES ON THE CEREMONIES OF THE HOPI.[1]

MR. H. R. VOTH is known to all students of North American ethnology for his researches into the sociology and religion of various Pueblo groups, and now, owing to the resources of the Stanley McCormick benefaction, they are indebted to him for further studies on the Hopi of Arizona. The description of the Oraibi winter and summer Marau ceremonies is the result of several partial observations in different years; as the ceremonies are sometimes going on day and night, it is a physical impossibility for one man to make an exhaustive study of a nine-day (and night) ceremony at one time, but a protracted study of the same ceremony, on different occasions, has several compensations, and it is evident that Mr. Voth has done all that was possible to render his account accurate and as complete as circumstances would permit.

As an instance of Mr. Voth's method, it may be mentioned that he gives the names of those who take important parts in the ceremonies. Even these isolated villages are subject to the social and religious influence of the white man, these careful investigations are of especial value. In addition, "Strife and contentions between the different factions have driven a large part of the inhabitants from the village [of Oraibi]. These have started new villages. This fact makes it highly probable that the Marau ceremony, as well as the others, will, in the future, never be the elaborate affairs that they used to be in the past."

FIG. 1.—The chief priest smoking over prayer offerings. From "The Oraibi Marau Ceremony."

[1] Field Museum of Natural History. Anthropological series, vol. xi., No. 1, Publication No. 156. "The Oraibi Marau Ceremony." By H. R. Voth. Pp. 88+plates. Vol. xi., No. 2, Publication 157. "Brief Miscellaneous Hopi Papers." By H. R. Voth. Pp. v+99-149. (Chicago, 1912).

The chief interest of the Marau Society is that it "is a woman's fraternity, and in Oraibi has its own kiva, or underground ceremonial chamber; but, as is the case with all women's societies, a number of men also belong to the order, who perform certain functions and control certain sacred objects in all the ceremonies." The cult conforms to the usual type of the ceremonies of the Pueblo Indians. There are altars with a screen of slabs of wood representing cornstalks, lightning, and deceased members of the order, at the sides are figurines of the deities of the order, in front is the medicine bowl with six ears of corn, aspergills, &c., trays with meal, rattles, bone whistles, and other articles used in the rites.

FIG. 2.—Children's burial places, top view. The piles of the smaller stones at the edge of the mesa, on some of which sticks and food bowls may be seen, indicate the crevice graves. From "Brief Miscellaneous Hopi Papers."

The ceremonies are too elaborate to describe; they consist largely of ceremonial smoking, asperging, sprinkling meal, offering feathered prayer-sticks, repeating prayers, and the like (Fig. 1). It is significant that this woman's ceremony is connected with agriculture, and that, as in other societies, the summer or autumn ceremonies are more elaborate than the winter performances. A free translation of one of the songs runs as follows:—"Now, then, here we array (decorate), these four different ones (somewhere in the four world quarters), our fathers, the chiefs (deities); therefore cooperate we here with our offerings. From somewhere, may, with their help, the four different ones (the deities of the four world quarters) have pity upon us quickly, and let it rain at the right time."

Mr. Voth has wisely given all the details he observed, but it would be very helpful if he would prepare a short synopsis of this and other ceremonies giving only such details as are sufficient to illustrate the symbolism of the ritual, and describing the real significance of the ceremony and the religious sentiments which it is designed to promote. Certain words in many songs, and often those of entire songs, are not understood by the Hopi; generally these are not archaic Hopi words or songs, but have been introduced from the Pueblo Indians on the Rio Grande—another example of cultural borrowing.

In the notes on modern burial customs of the Hopi Mr. Voth says that a child which has not yet been initiated into one of the religious societies is not buried in a cemetery but a crevice in the edge of the mesa (Fig. 2). A road is made then towards the child's home, because it is believed that the soul of that child returns to the house of its parents, and is reincarnated in the next child to be born in that family. Other notes deal with the Eagle cult of the Hopi, the Oraibi new year ceremony, the winter ceremony of the Drab Flute Society, and Hopi marriage rites. An important element in the last is the washing of the hair of the couple, "and especially the washing of the two heads in the same bowl is said to be the 'crucial moment' in which the two are supposed to 'become one.'" Most of the articles are richly illustrated by photographs.

A. C. HADDON.

DANA'S PROOF OF DARWIN'S THEORY OF CORAL REEFS.

JAMES DWIGHT DANA, born four years to a day after Darwin, on February 12, 1813, naturalist of the United States Exploring Expedition under Wilkes from 1838 to 1842, and afterwards until his death in 1895 professor of geology at Yale University, was for more than half a century a leading figure among American men of science. On the hundredth anniversary of his birth it is fitting to direct attention to the independent proof that he found many years ago for Darwin's theory of coral reefs, a proof that has long been overlooked, although it supplies the most important confirmation for the theory of subsidence that has ever been brought forward.

Darwin most ingeniously invented his theory of subsidence while he was in South America, before he had seen a true coral reef; he had afterwards only to test the theory by comparing its consequences with the facts that he observed during the voyage of the *Beagle* across the Pacific and Indian Oceans, and with the records of other explorers which he studied after his return home. The theory bore the test admirably; it was universally regarded as "true" for a generation, although apart from certain correlations of coral reefs with areas of recent uplift and with active and extinct volcanoes, which appear to be less assured now than seventy years ago, the theory of subsidence did not gain that increased probability of correctness which comes to a theory from the capacity to explain facts that were unknown or unnoticed when the theory was invented.

During the last thirty years several new theories of coral reefs have been introduced, and Darwin's theory has been more or less discredited in the minds of some investigators. Murray re-introduced what may be called the theory of outward growth, which Darwin had considered and adopted for certain special cases in association with subsidence; but in its new form subsidence was excluded from this theory, and two provisos were added as to the organic upbuilding of submarine banks until they reach the moderate depth at which they may serve as foundations for atolls, and as to the production of lagoons by the removal of the inner part of reefs by solution (Proc. Roy. Soc., Edin., ix., 1880, 505–518). Agassiz, in his world-wide explorations of coral reefs, emphasised the possible complications in their history; he pointed out the frequent occurrence of uplifted "coralliferous limestones," which might be worn down and dissolved away while fringing reefs grew around them, thus producing barrier reefs and atolls in association with elevation instead of subsidence. At the same time he reintroduced the idea—which Darwin had rejected on good grounds—that reefs could grow on the outer margin of platforms cut by the waves around volcanic islands, thus producing barrier reefs without subsidence, elevation, or solution (Bull. Mus. Comp. Zool., xxxiii., 1899; Mem. Mus. Comp. Zool., xxviii., 1903). Wharton went still farther in suggesting that a volcanic island might be worn down to a depth of twenty or twenty-five fathoms by marine agencies, thereby producing a flat submarine bank on which an atoll could afterwards grow up; thus accounting for atolls as Agassiz had for barrier reefs, without subsidence, elevation, or solution.

The possibility of producing barrier reefs and atolls by the wearing down of uplifted "coralliferous limestones," as suggested by Agassiz, may be regarded as a modification of any theory that will explain barrier reefs and atolls before the uplifts occurred. Darwin recognised at least one instance of wearing down an uplifted reef ("Coral Reefs," 1842, p. 55), and would certainly have welcomed the larger application of this process, had he known the results of modern exploration.

The formation of atolls by up-growth from submarine banks of proper depth is eminently possible, if the banks can be provided in sufficient number, but possibility is not proof. When subsidence is demonstrated as having taken part in the production of barrier reefs, as will be shown below, its exclusion from this theory of atolls is unreasonable.

The development of a foundation of atolls by the marine truncation of a volcanic island, as indicated by Wharton, is eminently possible, provided that floating coral larvæ do not establish themselves upon it until truncation is complete; but the ordinary relation of fringing and barrier reefs to their central islands shows that this proviso is inadmissible. The formation of a fringing reef will be begun as soon as a narrow platform is abraded, and such a reef once established, further truncation of the island by wave work is practically stopped. Moreover, the Alexa and other submarine banks described by Wharton can be explained by regarding them as submerged atolls quite as well as by regarding them as truncated volcanic islands; hence this theory is not satisfactory.

The formation of veneering barrier reefs on the outer margin of sea-cut platforms around still-standing islands, an old idea (see footnote in Darwin's "Coral Reefs," 1842, p. 49) recently given prominence by Agassiz, is open to the same difficulty that is fatal to Wharton's theory of truncation. However, if a barrier reef were ever formed in this manner, the central island should rise from the cut-back shore line in a wall of steep cliffs, as Darwin clearly stated, and the broader the platform, the simpler the outline of the cliff-walled island should become. It may be confidently asserted that the central islands of barrier reefs do not possess these significant features; hence there is no more reason for accepting this theory to-day than when Darwin rejected it.

The theory of outward growth and solution, advocated by Murray for the production of barrier reefs around volcanic islands, without subsidence, or even in areas of slow elevation, involves several consequences which, when compared with the facts, contradict its verity; for during the slow outward growth of the reef around a still-standing island, the streams from the mountainous interior must form deltas in the shallow water at their mouths, and by the time the reef has grown far enough outwards to be called a barrier, the delta plains must become more or less confluent laterally, thus forming a low alluvial plain around the original island, as Darwin clearly saw ("Coral Reefs," 1842, pp. 128–130). When such lowlands occur, they indicate a still-stand of the island; but their prevailing absence suffices to exclude the general application of the postulated still-stand.

It would thus appear that the theories of outward growth and solution for the production of barrier reefs, of marine truncation for the production of atolls, and of coral veneers on the margin of sea-cut platforms for the origin of barrier reefs, all fail to satisfy the requirements of observation, when they are tested by certain consequences that have not been explicitly stated by their inventors. It remains to be seen whether Darwin's theory of subsidence suffers the same fate when tested in the same manner.

The accompanying diagram (Fig. 1) exhibits three stages in the subsidence of a dissected volcanic island; the first stage shows a fringing reef, the second a barrier reef, the third an atoll, as indicated by Darwin's original figures, which are here reproduced in substance on the front face of each block. But the surface of the second block shows a feature which Darwin did not notice, although it is quite as essential a consequence of his theory as any other. This is the invasion of the previously eroded valleys of the subsiding island by the sea, so that the relatively simple shore line of the first stage is in the second stage transformed into an embayed shore line, possessing several of "those deep arms of the sea . . . which," as Darwin said, "penetrate nearly to the heart of some encircled islands" ("Coral Reefs," 1842, p. 49). So long as subsidence continues the bays cannot be filled with deltas and the ridges cannot be cut back in cliffs. Darwin recognised that the central island must diminish in size as it subsides, but he did not also perceive the necessary modification of its outline.

It requires but a brief examination of large-scale charts of the Pacific island-groups to discover that the central islands of barrier reefs are repeatedly characterised by an embayed shore line, that the bays are not filled with delta-plains, and that the ridge ends are not truncated in cliffs. Kandavu and Mbengha in the Fiji group (Admiralty chart 167), the western members of the Society group (chart 1060), and especially Bora Bora (1428), Gambier Island (1112), a western member of the Paumotus, and Rossel Island (1473), in the Louisiade archipelago of British New Guinea, may be instanced among many others as affording good illustration of at least some of these features, particularly of embayed shore lines.

In view of the remarkable accordance that is thus found between the inferred consequences of the theory of subsidence and the observed features of central islands of barrier reefs, and in memory of the failure of corresponding consequences of other theories to match the facts, an open-minded inquirer cannot hesitate long in making choice among the several explanations that have been suggested for barrier reefs, and with them, of atolls.

Dana first learned of Darwin's theory when the Wilkes expedition reached Sydney near the end of 1839. Several months earlier, during "the ascent of Mt. Aorai on Tahiti, in September of 1839," he had conceived the production of an embayed shore line as a necessary result of the subsidence of a dissected land mass. Let it be noted in passing that he was the first clearly to announce this important principle, which then had no place in geology or geography, although it is hinted at in De la Beche's "Researches in Theoretical Geology" (London, 1834, p. 193). In Dana's first report he says, when following Darwin in explaining barrier reefs and atolls by subsidence:—"The very features of the land, the deep indentations, are sufficient evidence of subsidence to one who has studied the character of the Pacific islands" ("Geology," U.S. Expl. Exped., 1849, p. 131); and on a later page a more explicit statement is made under the general heading, "Evidence of Subsidence," and the special heading, "Deep Bay-indentations in Coasts as the Terminations of Valleys":—"In the remarks upon the valleys of the Pacific islands, it has been shown that they were in general formed by the waters of the land, unaided by the sea; that the sea tends only to level off the coast, or give it an even outline. When, therefore, we find the several valleys continued on beneath the sea, and their enclosing ridges standing out in long narrow points, there is reason to suspect that the island has subsided after the formation of the valleys. For such an island as Tahiti could not subside even a few scores of feet without changing the even outline into one of deep coves or bays, the ridges projecting out to sea on every side. . . . The absence of such coves, on the contrary, is evidence that any subsidence which has taken place has been comparatively small in amount" (p. 393). Similar statements are made in Dana's first book on this subject, "On Coral Reefs and Islands" (New York, 1853, pp. 118–119), and in all the editions of his larger book, "Corals and Coral Islands" (New York, first edition, 1872, pp. 319–320; third edition, 1890, pp. 273–274).

It is remarkable how rarely the value of this capital point has been recognised. It is referred to in

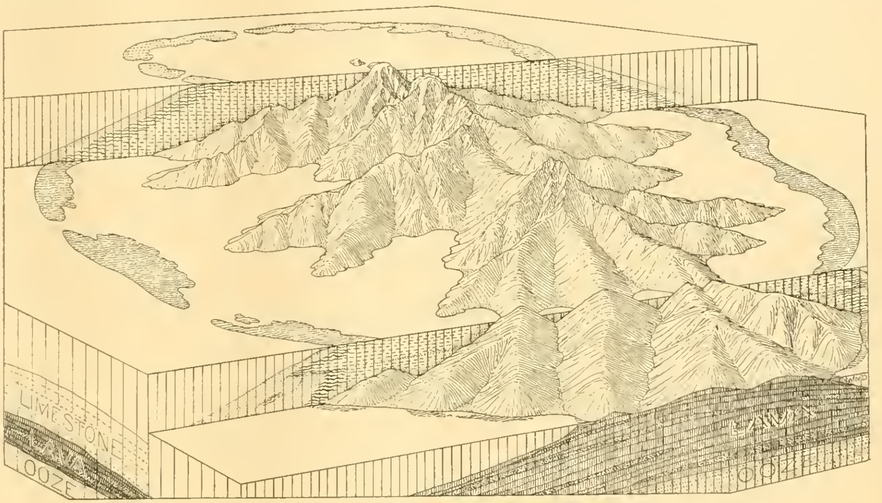

FIG. 1.—Stages in the subsidence of a dissected volcanic island.

Bonney's appendix to the third edition of Darwin's "Coral Reefs" (London, 1889, pp. 310–311), but without sufficient indication of its value as an independent and therefore important confirmation of Darwin's theory. It is noted by Krämer, who gives it local application in explaining certain bays on the Samoan islands, but without recognising its value in relation to the theory of subsidence in general ("Bau der Korallenriffe," Leipzig, 1897, p. 24). It is quoted by Gardiner, but without understanding of its importance, for he adds: "Such evidence when applied to volcanic islands is, I submit, of very doubtful value" (Proc. Camb. Phil. Soc., ix., 1898, p. 490). Murray does not refer to it; Agassiz quotes and rejects it in reference to the Marquesas Islands (Mem. Mus. Comp. Zool., xxviii., 1903, p. 5), and does not mention it elsewhere. Singularly enough, Darwin himself refers in the second edition of his book only twice, and then very briefly, to Dana's evidence of subsidence; both references concern the Marquesas Islands ("Coral Reefs," second edition, London, 1874, pp. 163, 201). I have found no other passage in which Darwin says a word upon the subject, although his discussion is otherwise marvellously complete. Dana's inference regarding the Marquesas is to be found in his report on the geology of the Wilkes Expedition (1849, p. 397), in his "Coral Reefs and Islands" (1853, p. 122), and in his "Corals and Coral Islands" (1872, p. 325; 1890, p. 361).

Doubtless other earlier writers cited Dana's principle, but it has not yet come to be generally accepted as an essential element in the demonstration that barrier reefs have been formed by subsidence. This is probably because an understanding of the reasonable evolution of coastal forms has not yet taken general possession of the scientific mind, or perhaps because some students of the coral-reef problem still adhere to the obsolete explanation of bays by marine erosion, an explanation that Dana explicitly excluded; can it possibly also be because there is as yet no sufficient understanding of the logical principle that a theory, even if it be well recommended by explaining the things that it was invented to explain, still needs confirmation by independent, unexpected evidence, before it deserves to be accepted as "demonstrated"?

Several recent writers on the coral-reef problem, particularly those in Australia, have recognised the value of the evidence for subsidence given by drowned valleys. The latest of these is Marshall, of Otago, New Zealand. He writes as follows regarding the Society Islands, in his recent essay on "Oceania" in the *Handbücher der regionalen Geologie*:—"The deep inlets that intersect the coast line . . . are clearly due to stream erosion. Prolonged marine action would have shallowed or filled them, or at least would have built up bars of coastal débris across the entrances. The author is therefore strongly of opinion that the absence of cliffs at the termination of the radiating spurs, the presence of deep water in the lagoon, and of far-reaching inlets, prove that marine erosion has not had any influence on the form of these islands at the present sea-level. . . . Finally, the deep inlets appear to be drowned stream valleys, and their nature strongly supports the belief that the islands have been subjected to an important movement of subsidence."

It is a pleasure to find a colleague who has a personal knowledge of coral islands and with whose opinion I can so closely unite, even though we are physically separated by the greatest distance that the earth affords. I am glad to join with him in emphasising the importance of Dana's principle as an independent confirmation of Darwin's theory of coral reefs.

W. M. DAVIS.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The readership in forestry will be vacant on March 31 by the resignation of Mr. A. Henry. The general board will in the Easter term appoint a reader. The annual stipend is 400*l*. Candidates are requested to send their applications, with such testimonials as they think fit, to the Vice-Chancellor on or before April 15.

OXFORD.—On February 4 the decree providing for the allocation of a site on the south side of the University Park for the erection of an engineering laboratory was not moved.

The subject of Prof. D'Arcy Thompson's Herbert Spencer lecture on February 14 has been altered to "Aristotle as a Biologist."

MR. R. H. MOODY has been appointed professor of mathematics at the Muir Central College, Allahabad.

MR. F. E. ARMSTRONG has been appointed to the professorship of mining in the University of Sheffield in succession to Prof. Hardwick.

A COURSE of three public lectures on the electrical properties of flames will be delivered in the Physics Theatre of University College, University of London, by Dr. E. N. da C. Andrade, on Mondays, February 10, 17, and 24, at 5 p.m.

THE first term of the newly formed University in Western Australia will open in March of this year. Three out of the eight chairs have been filled in England. That of chemistry will be taken by Dr. N. T. M. Wilsmore, and Dr. A. B. Ross will occupy the post of professor of mathematics and physics, both having left for Australia by R.M.S. *Moldavia* on January 30. Dr. Wilsmore has been associated with the University of London for some time, having held the position of assistant-professor of chemistry at University College. Dr. Ross has been assistant-professor of natural philosophy in the University of Glasgow. Dr. W. J. Dakin, assistant professor in the department of zoology and comparative anatomy in University College, London, will proceed to Western Australia by R.M.S. *Mongolia* on February 7, to occupy the chair of biology.

IN *The Quarterly Journal of Forestry* for January Prof. Fraser Story gives a short account of the School of Forestry at Selmeczbanya, Hungary. This school, which is about 150 miles north of Budapest, was founded in 1807, and is thus one of the oldest forestry schools on the Continent. There is also a mining school in the same building, and the combined staff of the two includes twenty professors each with an average of two assistants. No fees are charged except a registration fee of less than 1*l*.; on the other hand, liberal scholarships are provided by the Hungarian Government conditionally on the holders subsequently serving two years in the Government Forestry Department. As for the laboratory equipment, even the list of physical apparatus is on the most elaborate scale, the electrical instruments including galvanometers, amperimeters, voltameters, resistance boxes, alternating-current generators, transformers, rheostats, accumulators, Röntgen-ray apparatus, and Ruhmkorff coils giving sparks more than 18 in. long.

THE New Zealand University Reform Association has for some three years been urging on the public the need of various reforms, both in the constitution of the Senate and of the governing bodies of the four affiliated colleges, as well as in the method of examining for the degrees, and in a number of other less important directions. The Senate, at its meeting in January, 1912, summoned an annual conference of the professors of the four colleges; the first meeting was held in November, when it was resolved to recommend to the Senate the merging of the two degrees of B.A. and B.Sc. into one, to be called B.A. The attempt by the reformers to introduce the system of intermediate and final examinations for the degree was thrown out, and the general scheme of the Conservatives, if we may so call them, was adopted. It was also resolved to recommend that at the end of five years the present system of examination should cease, and that examinations be conducted by boards of examiners, composed of the New Zealand professors.

THE second part, dealing with financial statistics for 1910–11–12, of "Statistics of Public Education in England and Wales," is now available (Cd. 6551). In the year ending March 31, 1912, the net total expenditure by the Board of Education in England and Wales was 14,298,030*l*. Of this 11,775,390*l*. was spent on elementary education, 758,525*l*. on secondary schools, 587,213*l*. on technical and art schools and classes, and 571,143*l*. on the training of teachers. The amounts allocated definitely to higher education were small; among these sums may be mentioned 20,000*l*. to the Imperial College of Science and Technology, 17,238*l*. to the Science Museum at South Kensington, and 20,170*l*. for the Geological Museum and Geological Survey. A table giving the expenditure of local authorities in England on education other than elementary is of special interest. Their total receipts for this purpose were 4,327,842*l*., somewhat less than their total expenditure. Of this amount 1,081,835*l*. was from Parliamentary grants, 1,840,155*l*. from rates and borough funds, and 193,957*l*. from local authorities.

THE report for the third session of the faculty of engineering in the University of Bristol has now been published. During the session 1911–12, seventy-four day students attended, of whom fifty-three were matriculated students of this University; the percentage of matriculated students, which was forty in 1909–10 and fifty-eight in 1910–11, increased to seventy-one. This is higher than the corresponding percentage of matriculated engineering students in other provincial universities. Of these day students, three were engaged in post-graduate research work. The number of individual students in attendance at the evening classes conducted by members of the teaching staff of the faculty was 444; of these, eighteen were registered as candidates for the university degree or certificate in engineering, and two had matriculated. The report points out that each year it becomes easier to find places for students who have completed their courses of study. This arises partly from the fact that employers are realising the benefits to be derived from engaging recruits who have had a sound technical training, and partly that students unwilling to work hard enough are dissuaded from continuing their studies. This reduces the number of students in the faculty, but increases enormously the efficiency of the work.

IN his recent report on the work of the Massachusetts Institute of Technology, President R. C. Maclaurin says there can in future be no serious talk of merging the institute with Harvard University, but he shows at the same time how desirable proper cooperation between the two colleges is. The Institute of Technology has received during the past year gifts amounting to about 1,200,000*l*., and is strong enough either to stand alone or to enter into alliances. Dr. Maclaurin shows how unwise it would be for the institute to establish a group of collections for its students when the splendid University Museum of Harvard is so close at hand. The institute, he points out, is intending to erect the most complete mining and metallurgical laboratories in the world, and it would be a waste of money for Harvard to try to duplicate these. He believes that there should be a further interchange of the strong teachers in both institutions. For years the institute students in geology have had the advantage of Prof. Daly's skill, enthusiasm, and scientific achievements, and now he has gone to Harvard it would be regrettable if the students should be out of his influence, the more so since the number of advanced students in the two schools together is not too large for him to deal with effectively. In return, Harvard is not likely, Dr. Maclaurin says, to attempt the task of duplicating such a man as Prof. Lindgren, now at the institute.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 23.—Sir Archibald Geikie, K.C.B., president, in the chair.—E. **Mellanby**: The metabolism of lactating women.—Dr. F. W. **Edridge-Green**: Colour adaptation. As in dark adaptation there is a considerable effect which takes place immediately on entering a dark room, so is there a considerable effect produced when a person enters a room illuminated by an artificial light, having previously been in daylight. This effect, which may be designated colour adaptation, increases with the time during which the eyes are subjected to the adapting light. The effect of colour adaptation was estimated by four methods. —Dr. F. W. **Edridge-Green**: Trichromic vision and anomalous trichromatism. The following are the conclusions arrived at after the examination of a large number of persons belonging to each class:—(1) Trichromic vision (on the author's classification of colour-vision) is not synonymous with anomalous trichromatism. (2) Many persons with otherwise normal colour perception make an anomalous equation. (3) Many colour-blind persons (dichromics and trichromics) make an absolutely normal match with no greater mean deviation than the normal. (4) Colour weakness is not characteristic of anomalous trichromatism but of trichromic vision. (5) Anomalous trichromatism and colour weakness are not synonymous. (6) A large mean deviation indicates colour weakness. (7) Anomalous trichromatism appears to be due to an alteration in the normal relations of the response to the three colours (lights) used in the equation.—W. E. **Agar**: The transmission of environmental effects from parent to offspring in *Simocephalus vetulus*. The main result of a number of experiments on the transmission of environmental effects in a common Daphnid, *S. vetulus*, has been to show that certain characters, acquired ontogenetically by individuals placed in abnormal environments, may appear in their offspring which have been born and have lived in a normal environment, *i.e.* one in which control individuals do not show the characters in question.—Dorothy M. **Cayley**: A preliminary note on a new bacterial disease of *Pisum sativum*.—Dr. J. **Homans**: The relation of the islets of Langerhans to the pancreatic acini under various conditions of secretory activity. H. O. **Feiss** and W. **Cramer**: Contributions to the histo-chemistry of nerve; on the nature of Wallerian degeneration.—I. B. J. **Sollas**: Onychaster, a Carboniferous brittle-star.—Prof. H. E. **Armstrong**, E. F. **Armstrong**, and E. **Horton**: Herbage studies. II., Variation in *Lotus corniculatus* and *Trifolium repens* (cyanophoric plants). During the past summer, by testing very carefully the apparently acyanophoric form of *L. corniculatus* described in part i., it has been found that this contains a minute proportion of cyanide; moreover, two varieties of this form have been met with, in close proximity, the one rich in enzyme, the other having little, if any, enzymic activity towards linamarin. The manner in which the plant has been found to vary, especially in different parts of Scotland, is discussed at some length. Attention has also been directed to white clover in particular, on account of its importance as the chief leguminous plant in pasture lands. The authors have been forestalled by Mirande (C.R., 1912, vol. clv., p. 651) in the discovery that this plant is cyanophoric, like *L. corniculatus*. But their observations go further and show that whilst the wild form of *T. repens* is uniformly more or less cyanophoric, the cultivated form is destitute of cyanide.—T. G. **Brown**: The phenomena of "narcosis progression" in mammals.—Prof. C. S. **Sherrington**: Reciprocal innervation and symmetrical muscles.—Dr. F. **Medigreceanu**: The manganese content of transplanted tumours.—Dr. J. W. W. **Stephens** and Dr. B. **Blacklock**: The non-identity of *Trypanosoma brucei* (Plimmer and Bradford, 1899) with the trypanosome of the same name from the Uganda ox. In this paper the authors deal with the *T. brucei* causing Nagana in Zululand and *T. brucei* of Uganda. It has generally been accepted that these two trypanosomes are (morphologically) identical, and that they are both of the dimorphic type, presenting long free flagellated forms and short stumpy forms without free flagellum. The name *T. brucei* was first given by Plimmer and Bradford to the parasite, but they do not mention short stumpy aflagellar forms. Again, Laveran regards *T. brucei* as a monomorphic trypanosome which always has a free flagellum. The authors have had the opportunity of examining both strains of *T. brucei, i.e.* that from Zululand and that from Uganda, and in addition have had access by the courtesy of several observers to their films of the Zululand strain. As a result of their investigations they have come to the conclusion that the trypanosome called *brucei* from Uganda presents very distinct and obvious morphological differences from the Zululand parasite. In order to avoid confusion, it is considered advisable that this Uganda trypanosome should be re-named, and the name *T. ugandae* is proposed.

January 30.—Sir Archibald Geikie, K.C.B., president, in the chair.—Prof. W. H. **Young**: The formation of usually convergent Fourier series.—R. V. **Southwell**: The general theory of elastic stability. The paper deals principally with the general principles which govern the mathematical investigation of problems in elastic stability, but two examples of some importance are considered for purposes of illustration, viz. the problems of the boiler flue and of the tubular strut.—C. M. **Stubbs**: A spectro-photometric comparison of the emissivity of solid and liquid copper and of liquid silver at high temperatures with that of a full radiator. (1) The emissivity of solid and liquid copper and of liquid silver at high temperatures, relative to that of a full radiator at the same temperatures, has been measured throughout the visible spectrum. (2) As in the case of gold, the emissivity of copper is discontinuous at the melting point, the "relative emissivity" curve of the liquid showing no flexure. (3) The curve of "relative emissivity" of solid copper at high temperatures differs considerably from that of absorptivity at low temperatures. It possesses a much less marked flexure in the green, and it is suggested that this is due to the same causes which ultimately bring about the total absence of a marked bend in the curve for the liquid. (4) Contrary to Burgess's results, no appreciable temperature coefficient of "relative emissivity" was found for liquid copper over a range of 100°. (5) The "relative emissivity" of liquid silver is throughout remarkably low, but seems to be somewhat greater than the corresponding values of the absorptivity of solid silver at ordinary temperatures. (6) "Black body" temperatures of solid and liquid copper and of liquid silver at the respective melting points are calculated.—G. W. **Walker**: A new analytical expression for the representation of the components of the diurnal variation of terrestrial magnetism. Attention is directed to the fact that Fourier analysis of the observed diurnal variation of the components of terrestrial magnetic force does not lead to a concise specification of the data. Thus progress towards a knowledge of the physical causes has been limited. It is suggested that the phenomena are probably purely diurnal, that no physical significance may attach to the twelve-hour, eight-hour, &c., terms, but that the facts may be more suitably expressed by a function that recurs only once in twenty-four hours.—Prof. E. W. **Marchant**: An investigation into the magnetic behaviour of iron and some other metals under the oscillatory discharge from a condenser. The method adopted in the investigation was to photograph by a revolving mirror the spark caused by the discharge. In order to check the accuracy of measurement spark photographs were taken of the discharge from an air condenser through an air-core inductance. The agreement between calculated and observed frequencies was within 1 per cent. With a glass condenser the capacity measured by the frequency of the discharge through an air-core self-induction was less than that obtained by ballistic measurements. When the discharge from these condensers was passed round a coil having a core of fine iron wires, the discharge consisted of a series of oscillations, the time for each oscillation increasing as the discharge died away. The discharge was much more quickly damped when the iron wire core was inserted. From the measurements of the first half oscillations of a number of discharges the "effective permeability" of the iron wire core was calculated, the "effective permeability" being defined as that which the iron would have if it were constant, in order to give an oscillation of the same periodic time as that which was observed. From these results a curve has been drawn giving the relation between magnetising force and "effective permeability." This curve has been employed to determine approximately the resistance of the spark.—Florence **Isaac**: The spontaneous crystallisation and the melting- and freezing-point curves of two substances which form mixed crystals and the freezing-point curve of which exhibits a transition point. Mixtures of *p*-bromonitrobenzene and *p*-chloronitrobenzene.

Geological Society, January 8.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—J. B. **Scrivenor**: The geological history of the Malay Peninsula. A brief statement of the information bearing on the geological history of the Malay Peninsula gathered since 1903. During the Mesozoic era earth-movements took place in a part of the crust now the site of the Malay Peninsula. These movements resulted in two anticlinal folds. The folding admitted of the intrusion of two masses of granite, accompanied by faulting of the rocks in the folds. The rocks affected by the folding are the Raub Series of calcareous rocks, and the Malayan Gondwana rocks. The palæontological evidence cannot be reconciled with the field evidence. No fixed horizon has been discovered in these rocks, which may be either Carboniferous or Permo-Carboniferous. At the base of the Gondwana rocks are glacial deposits to be referred to the same horizon as the late Palæozoic glacial deposits of Peninsular India, the Salt Range, Australia, and South Africa, but this horizon cannot be defined exactly. Its presence shows that the Raub Series must be older than the Productus Beds of the Salt Range, or equivalent to the shales below the boulder-bed in the trans-Indus section of the Salt Range. The glacial deposits are succeeded by littoral deposits, and far to the east of the glacial deposits a Rhætic horizon has been described and named the Myophorian Sandstone. The glacial deposits show that this portion of the Gondwanaland coast contained stanniferous granite and also much corundum. Denudation has brought to light the two anticlinal folds and the granite masses upon which they now rest. On the west is the Main Range Anticline, on the east the Benom Anticline. The eastern limb of the former and the western limb of the latter meet in the Main Range Foothills. The eastern limb of the Benom Anticline is formed by the main Gondwana outcrop. The igneous rocks of the Benom Anticline are less acid than those of the Main Range Anticline. The area of the Benom Anticline coincides with the "gold-belt" of the peninsula. Tertiary Coal Measures, unconformable on the Gondwana rocks, are known in Selangor. Their exact age cannot be determined. Evidence has been found in the peninsula supplementing the evidence described by Dr. A. R. Wallace, of changes in the archipelago in Tertiary times. When the land-connection that allowed the migration of the fauna of the archipelago from the north was destroyed by submergence, the subsidence continued until the peninsula became an island or group of islands. Subsidence then gave place to elevation, which restored the peninsula.—C. T. **Trechmann**: A mass of anhydrite in the Magnesian Limestone at Hartlepool. The harbour of Hartlepool owes its existence to the erosion of a mass of anhydrite of great thickness, proved by boring to exist in proximity to the Upper Magnesian Limestone upon which the towns of Hartlepool and West Hartlepool are built. The anhydrite is included in, and represents the time-equivalent of part of, the Middle and part of the Upper Limestones. The former presence of sulphates in the Magnesian Limestone is discussed. Evidence is brought to show that quantities of anhydrite were originally deposited with the Magnesian Limestone, the subsequent hydration and removal of which are responsible for the collapse, brecciation, and other alterations that are features of the present formation. The distribution of organisms in the Magnesian Limestone was influenced by the sulphates present in the water. The Shell Limestone is a chain of reef-knolls. The curious distribution and present position of the Upper Magnesian Limestones in Durham is noticed, and an explanation offered. The Permian succession is shown to be more complete in the southern than in the northern area of the county. Various sections in the Upper and Upper Middle Limestones in the Hartlepool area are described.

Linnean Society, January 16.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Prof. E. L. **Bouvier**: Les Caridines des Seychelles, avec des observations sur leurs variations.—Rev. A. E. **Eaton**: (1) Psychodidæ of the Seychelles. (2) Ephemeridæ of the Seychelles.—H. **Campion**: Odonata of the Seychelles.—W. A. **Harding**: A new land leech from the Seychelles.

Physical Society, January 24.—Prof. C. H. Lees, F.R.S., vice-president, in the chair.—S. W. J. **Smith** and H. **Moss**: The resistance of electrolytes. In experiments described in 1911 a modification of Wien's method was used—the optical telephone being replaced by a vibration galvanometer—and the conclusion was drawn that the resistance of an electrolyte varies to an easily perceptible degree with the frequency of the alternating currents to which it is subjected. It is unsound to use the method to test whether the resistivity of an electrolyte depends upon the frequency of the currents to which it is subjected, unless it is shown that the effects of leakage through the electrolytic condensers can be neglected or allowed for. In order to remove or justify any doubt upon the question test experiments have been performed. The method depends upon simultaneous measurement of the voltage between the ends of a tube containing the electrolyte and of the current passing through it. It was found that the resistivity of the electrolyte was constant within 0·05 per cent., whether steady currents or currents of any frequency up to 2300 alternations per second were used. Until the instruments were calibrated there appeared to be a small difference of about 1 part in 600 between the resistance as measured by continuous currents and the values obtained with alternating currents. Some experiments were made with the object of elucidating the behaviour of the instruments which this calibration disclosed. The fact that the apparent contact P.D. within the voltmeter was a function of the applied voltage, decreasing as the latter was raised, would cause an effect of the same sign as that observed. Unallowed-for leakage, greater with steady than with alternating currents, might also provide a partial explanation of the results.—W. S. **Tucker**: The electrical conductivity and fluidity of strong solutions. In adopting Callendar's association theory of strong solutions difficulty is experienced in getting the strongest solutions of electrolytes to conform to the laws. This is attributed to the inaccuracy of the ionisation data. It may be supposed that the viscosity of the solution will affect its conductivity, and experiments to determine if there were any relation between conductivity and fluidity in the case of calcium chloride solutions were carried out. The feature is the simultaneous observation of viscosity, electrolytic resistance, and temperature. Solutions were contained in an unsilvered Dewar cylinder. A platinum thermometer records the temperature. While the thermometer oscillates the readings of electrical resistance were measured. The viscometer was in the form of a capillary pipette immersed in the solution to a known depth. Viscosities correct to less than 1 per cent. were obtained. Perfectly smooth curves for conductivity and fluidity were obtained. No connection between conductivity, fluidity, and concentration can be derived if the last is expressed in terms of volume, but if concentration is expressed as a ratio of masses—molecules of solute to 100 molecules of solvent—the ratio conductivity C/fluidity F stands in linear relation to the concentration n when the latter exceeds one-fourth its maximum value. One solution of nearly cryohydric strength was examined at temperatures from 40° C. to −50° C. The failure of the fluidity-temperature and conductivity-temperature curves to exhibit the same variations was shown. Conductivities of solutions were examined from 40° C. to their freezing points and the curves C/n and temperature plotted. The increasing curvature with concentration is shown, and the error involved in applying the ratio, molecular conductivity to that at infinite dilution, obtained at one temperature, to indicate ionisation at another temperature, is quite apparent. The results obtained suggest that no dependence can be placed on ionisation data derived from electrical conductivity observations.

DUBLIN.

Royal Irish Academy, January 13.—Rev. Dr. Mahaffy, president, in the chair.—H. **Ryan** and J. **Algar**: Montanic acid and its derivatives. The formula of montanic acid is $C_{28}H_{56}O_2$. The acid was converted into its methyl, ethyl, and propyl esters, and the esters when treated with alkyl magnesium halides gave tertiary alcohols, such as dimethyl- and diethyl-heptacesyl carbinol, diphenyl-heptacesyl carbinol, and the corresponding di-*p*-tolyl and di-α-naphthyl compounds. The chloride and amide of the acid were prepared, and an unsuccessful attempt to descend the series was made.—H. **Ryan** and Rev. R. **Fitzgerald**: Identity of baphinitone with homopterocarpin. In view of a possible relationship between the colourless, crystalline constituents and the red dye of barwood the authors isolated and examined baphinitone. They found that the latter substance, which was discovered by Anderson in 1876, is lævorotatory, and is identical with homopterocarpin, which was isolated in 1874 by Cazeneuve from Sanderswood. Bromination of homopterocarpin gives a colourless crystalline derivative, the formula of which is $C_{17}H_{14}Br_2O_4$.

January 27.—Rev. Dr. Mahaffy, president, in the chair.—G. P. **Farran**: Marine Entomostraca (in connection with the Clare Island Survey). Four species of Cladocera, sixty-five Ostracoda, and 152 Copepoda are recorded from the Clare Island district. The list of Ostracoda, due almost altogether to the work of Brady and Norman, comprises two-thirds of the total number known from the west coast of Ireland, and probably includes all the common forms. The list of Copepoda is, as regards its largest section, the littoral species, merely a preliminary one, and it is evident, on comparing it with the fauna of other localities, that, although it adds at least seventy species to the Irish fauna, it does not contain half the species which may be expected to occur. Four new species of Copepoda are described in the paper.

EDINBURGH.

Royal Society, January 6.—Prof. Hudson Beare, vice-president, in the chair.—Dr. G. E. **Gibson**: A method of determining vapour densities at high temperatures, and a new form of quartz manometer. The essential feature of the manometer was the thin flexible membrane which terminated the small quartz bulb, and which responded to the changes of pressure in the same manner as the metallic membrane in an aneroid barometer. To this membrane was attached a small quartz plate, the upper surface of which was polished so as to act as a mirror. Close to this quartz mirror, and lying as nearly as possible in the same plane, was a second quartz mirror attached by a rigid connection to the quartz tube, the enlargement of which formed the bulb. The reflected ray from this second mirror acted as the zero with reference to which the movements of the first mirror were measured. With this apparatus highly accurate measurements had been made on mercury vapour and on phosphorus vapour up to temperatures of 912° C. and 1250° C. respectively.—J. S. **Anderson**: The absorption of light by inorganic salts. No. vii., aqueous solutions of iron salts.—A. R. **Brown**: The absorption of light by inorganic salts. No. viii., alcoholic solutions of copper, cobalt, and nickel salts in the ultra-violet. These were further instalments of a series of investigations planned by Dr. Houstoun. In the case of the iron salts, both the visible spectrum and the infra-red were studied. It was found that ferric chloride and ferric bromide showed the same increase in absorption with concentration which characterised the chlorides and bromides of cobalt, nickel, and copper. The formation of colloid hydroxide was a disturbing factor in the case of weak solutions of ferric salts. The alcoholic solutions were studied in the ultra-violet region, and the conditions were found to be very complex. The absorption of light by ethyl alcohol was also measured for the first time.

PARIS.

Academy of Sciences, January 27.—M. F. Guyon in the chair.—E. H. **Amagat**: The laws of corresponding states.—L. **Maquenne** and E. **Demoussy**: The value of the respiratory quotient for green plants. Modifications in the method of measuring respiratory coefficients have been described by the authors in earlier papers; data are now given for forty-six plants. The coefficient for young plants is generally greater than unity, and this appears to hold for all green leaves during their period of active growth.—Pierre **Duhem**: The adiabatic growth of entropy.—M. **Graebe** was elected a correspondant for the section of chemistry in succession to Sir William Ramsay, elected foreign associate.—Francesco **Severi**: The algebraic correspondences existing on the curves of a linear system traced on a surface.—A. **Rosenblatt**: The algebraic surfaces which possess an irrational bundle of curves of genus 2.—V. **Kostitzin**: Some remarks on complete systems of orthogonal functions.—Angelo **Tonolo**: The potential of an analytical line.—E. **Benoit**: Formula appropriate to the calculation of the coordinates of the summits of a primordial geodesic chain.—Ch. **Maurain** and A. **Toussaint**: The measurement of pressures and rarefactions on large surfaces in motion in the air. Results of experiments bearing on the motion of aëroplanes.—Marcel **Brillouin**: The theory of black radiation.—A. **Schidlof** and Mlle. J. **Murzynowska**: The application of the law of Stokes to the fall of very small drops, and the determination of the charge of the electron. An experimental study of the fall of minute drops of olive oil in air, a modification of Millikan's method being employed. Cunningham's theorem was found to be applicable in this case.—P. **Vaillant**: A method of measuring large polarisable resistances and its application to the measurement of the resistance of bubbles in a liquid.—A. **Perot**: Certain peculiarities of the velocity of the luminous centres in hydrogen tubes.—Marcel **Boll**: The measurement of the energy of an ultra-violet radiation given off by a mercury arc working under different conditions. The difference of potential was found to be a linear function of the watts consumed by the lamp. The energy of wave-length 2536 A.V. emitted by a mercury arc is a parabolic function of the power expended.—Félix **Bidet**: The displacement of the primary amylamines by ammonia gas.—Emile **Baud**: The partial miscibility of liquids.—A. **Portevin**: The deformation of the plastic alloys and their annealing after deformation. For an isolated grain of the alloy the elastic limit is a vectorial quantity, and the effect of a deformation depends on the direction of the applied force.—Paul **Pascal**: Remarks on the additivity of diamagnetism in combination. A comparison of atomic magnetisation coefficients determined directly with those found in combination shows a close agreement, proving that this coefficient is an additive property.—P. **Lebeau** and A. **Damiens**: A method of analysis of mixtures of hydrogen and saturated gaseous hydrocarbons. Complex mixtures. A development of the method described in an earlier paper, based on fractional distillation at low temperatures, together with a eudiometric analysis of the fractions, each fraction containing only two hydrocarbons. Details are given of the results of the analysis by this method of a mixture of ethane, propane, and butane.—E. **Chablay**: Some reactions of sodium amide in presence of liquid ammonia. Formation of ethylenic hydrocarbons. The alkyl iodide, if allowed to fall into sodium amide in suspension in liquid ammonia, generally reacts with production of an unsaturated hydrocarbon, propyl iodide giving propylene, and isobutyl iodide, isobutylene; methyl iodide behaves differently, methylamine being formed.—Ém. **Bourquelot**, H. **Hérissey**, and M. **Bridel**: Syntheses of galactosides of alcohol with the aid of emulsine. β-Propylgalactoside and β-benzylgalactoside.—Marcel **Godchot** and Félix **Taboury**: α-Chloro*cyclo*pentanone and its derivatives.—Albert **Robin**: The comparative mineral contents of regions of the liver affected by cancer and regions relatively healthy. Cancerous liver contains a higher proportion of mineral matter than healthy liver; the composition of the mineral matter is also modified in the parts affected by cancer.—A. **Desmoulière**: The antigen in the Wassermann reaction. Further remarks on the preservation and use of the syphilitic antigen, the prepartion of which has been described in earlier communications.—L. **Tribondeau**: The use of plant extracts in the Wassermann reaction. Extracts of certain plants (oats, lentils, peas) behave like animal lipoid extracts; they become the complement in presence of syphilitic sera, but not with normal sera. The most suitable solvents are indicated.—E. **Bodin** and F. **Chevrel**: The bacterial purification of oysters in filtered sea-water. Experiments confirming those of M. Fabre-Domergue, proving the complete bacterial purification of oysters in artificial sea-water in six days.—J. **Loris-Mélikov**: Anaerobic bacteria in typhoid fever.—F. **Maignon**: Influence of the seasons and of the genital glands on respiratory combustion in the guinea-pig.—Jacques **Mawas**: The function of the conjunctive tissue of the ciliary body, in the transmission of the contraction of the ciliary muscle, and the importance of the zonule in the accommodation of the eye.—Éd. Le **Danois**: The Medusæ collected in the plankton during the 1912 expedition of the *Pourquoi-Pas?* in the North Sea, under the control of Dr. J. B. Charcot.—M. **Painvin**: The prosiphon of the Spirula.—E. **Chaput**: An attempt to date the old alluvial deposits of the Loire and its affluents.—Robert **Douvillé**: The individuality of the Ammonite fauna in the *Peltoceras athleta* layers.—R. de **Kövesligethy**: Study of the constitution of the globe by means of the seismic radii.

BOOKS RECEIVED.

Coal, and the Prevention of Explosions and Fires in Mines. By Dr. J. Harger. Pp. vii+183. (Newcastle-on-Tyne: A. Reid and Co., Ltd.; London: Longmans and Co.) 3*s*. 6*d*. net.

Hausa Superstitions and Customs. By Major A. J. N. Tremearne. Pp. xv+548+plates+map. (London: J. Bale, Ltd.) 21*s*. net.

The Travels of Ellen Cornish. By Dr. Vaughan Cornish. Pp. xvi+293+65 plates. (London: W. J. Ham-Smith.) 12*s*. 6*d*. net.

La Biologie Synthétique. By Prof. S. Leduc. Pp. iii+206. (Paris: A. Poinat.)

Cambridge County Geographies: Middlesex. By G. F. Bosworth. Pp. x+165+2 maps. (Cambridge University Press.) 1*s*. 6*d*.

The Vertebrate Skeleton. By Prof. S. H. Reynolds. Second edition. Pp. xvi+535. (Cambridge University Press.) 15*s*. net.

Text-book of Mechanics. By Prof. L. A. Martin, jun. Vol. iv., Applied Statics. Pp. xii+198. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 6*s*. 6*d*. net.

Messmates: a Book of Strange Companionships in Nature. By E. Step. Pp. xii+220+48 plates. (London: Hutchinson and Co.) 6*s*. net.

Injurious Insects: How to Recognise and Control Them. By Prof. W. C. O'Kane. Pp. xi+414. (New York: The Macmillan Company; London Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Eugenics Record Office. Bulletins Nos. 1, 4, 5, 6, 7, 8. Memoir No. 1, The Hill Folk. Report on a Rural Community of Hereditary Defectives. By F. H. Danielson and C. B. Davenport. Pp. v+56+3 charts. Memoir No. 2, The Nam Family. A Study in Cacogenics. By A. H. Estabrook and C. B. Davenport. Pp. iii+85+4 charts. (Cold Spring Harbor, New York.)

Mendel's Principles of Heredity. By W. Bateson. Pp. xiv+413+vi plates. (Cambridge University Press.) 12*s*. net.

Propriétés Cinématiques Fondamentales des Vibrations. By A. Guillet. Pp. 405. (Paris: Gauthier-Villars.) 16 francs.

Guide Scientifique du Géographe-Explorateur. By P. Crépin de Beauregard. Pp. x+250+2 plates. (Paris: Gauthier-Villars.)

The Petrology of the Sedimentary Rocks. By Dr. F. H. Hatch and R. H. Rastall, with an Appendix on the Systematic Examination of Loose Detrital Sediments. By T. Cook. Pp. xiii+425. (London: G. Allen and Co., Ltd.) 7*s*. 6*d*. net.

A Dictionary of Entomology. By N. K. Jardine. Pp. ix+259. (London: West, Newman and Co.) 6*s*. net.

Chemie der Fette, Lipoide und Wachsarten. By Dr. W. Glikin. Erster Band. Pp. xvi+789. Zweiter Band. Pp. xi+788. (Leipzig: Gebrüder Borntraeger.) 72 marks.

"Red Books" of the British Fire Prevention Committee. No. 177, Fire Tests with Fire Extinguishers. Petrol Fire Extinguishers, &c., the Committee's Report. Pp. 32. (London: 8 Waterloo Place, S.W.) 2*s*. 6*d*.

Heaton's Annual, 1913. Pp. 574. (Toronto; London: Simpkin and Co., Ltd.) 5*s*.

An Introduction to Zoology. By R. Lulham. Pp. xv+457. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*.

The Duab of Turkestan. By W. R. Rickmers. Pp. xv+564+illustrations+2 maps. (Cambridge University Press.) 30*s*. net.

Black's Sentinel Readers. By Prof. E. E. Speight. Book VI. Pp. xii+254+8 plates. (London: A. and C. Black.) 1*s*. 9*d*.

An Elementary Historical Geography of the British Isles. By M. S. Elliott. Pp. x+172+plates. (London: A. and C. Black.) 1*s*. 6*d*.

The Plant Alkaloids. By Dr. T. A. Henry. Pp. vii+466. (London: J. and A. Churchill.) 18*s*. net.

The Interpretation of Radium. By F. Soddy. Third edition, revised and enlarged. Pp. xvi+284+plates. (London: J. Murray.) 6*s*. net.

Volcanoes: their Structure and Significance. By Prof. T. G. Bonney. Third edition. Pp. 379+xvi plates. (London: J. Murray.) 6*s*. net.

Heredity. By Prof. J. A. Thomson. Second edition. Pp. xvi+627+plates. (London: J. Murray.) 9*s*. net.

Statische und kinetische Kristalltheorien. By Dr. J. Beckenkamp. Erster Teil. Pp. viii+206. (Berlin: Gebrüder Borntraeger.) 9.60 marks.

A History of British Mammals. By G. E. H. Barrett-Hamilton. Part xiii. (London: Gurney and Jackson.) 2s. 6d. net.

The Syrian Goddess. By Prof. H. A. Strong. Edited, with Notes and an Introduction, by Dr. J. Garstang. Pp. xiii+111. (London: Constable and Co., Ltd.) 4s. net.

The New Steam Tables, together with their Derivation and Application. By Prof. C. A. M. Smith and A. G. Warren, with an Introduction by Sir J. A. Ewing. Pp. xii+101. (London: Constable and Co., Ltd.) 4s. net.

Legislative Assembly. New South Wales. Second Report of the Government Bureau of Microbiology, dealing with work performed during the years 1910–11. Pp. 244. (Sydney: W. A. Gullick.) 5s.

Indian Civil Veterinary Department Memoirs. No. 3. Report of the Research Work of the Imperial Bacteriological Laboratory, Muktesar, during 1910–11. by Major J. D. E. Holmes. Pp. 276+xxii plates. (Calcutta: Thacker, Spink and Co.)

Memoirs of the Geological Survey. England and Wales. Explanation of Sheet 338. The Geology of Dartmoor. By C. Reid and others. Pp. vi+102+2 plates. (London: H.M.S.O.; E. Stanford, Ltd.) 2s. 3d.

Annual Report of the Board of Regents of the Smithsonian Institution for the year ending June 30, 1911. Pp. xii+688+plates. (Washington: Government Printing Office.)

Journal of the Academy of Natural Sciences of Philadelphia. Second Series. Vol. xv. Published in Commemoration of the One Hundredth Anniversary of the Foundation of the Academy, March 21, 1912. Pp. cxliv+614+lix plates. (Philadelphia.)

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.—The Influence of the Resilience of the Arterial Wall on Blood Pressure and on the Pulse Curve: S. R. Wells and L. Hill.—The Occurrence of a Ganglion in the Human Temporal Bone not hitherto described: A. A. Gray.—The Action of Adrenin on Veins: J. A. Gunn and F. B. Chavasse.—A Preliminary Report on the Treatment of Human Trypanosomiasis, and Yaws, with Metallic Antimony: Capt. H. S. Ranken. Further Researches on the Extrusion of Granules by Trypanosomes and on their Further Development. (With a Note by H. G. Plimmer on a New Method of Blood Fixation): Major W. B. Fry and Capt. H. S. Ranken.

ROYAL INSTITUTION, at 3.—Recent Research on the Gas Engine: Prof. B. Hopkinson.

LINNEAN SOCIETY, at 8.—Crosses of a Wild Pea with Cultivated Types: A. W. Sutton.—*Rhexoxylon africanum*, a New Medullosean Stem: N. Bancroft.—Revision of the Linnean Types of Palæarctic Rhopalocera: Dr. R. Verity.

FRIDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 9.—Life in the Great Oceans: Sir John Murray, K.C.B.

GEOLOGISTS' ASSOCIATION, at 8.—The Weathering Down of the Rocks: J. W. Evans.

SATURDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

MONDAY, FEBRUARY 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

ROYAL SOCIETY OF ARTS, at 8.—The Art of Miniature Painting: C. Davenport.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Applications of Polarised Light to Mechanical Engineering Problems of Stress Distribution: Prof. E. G. Coker.

TUESDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—The Heredity of Sex and some Cognate Problems: Prof. W. Bateson

INSTITUTION OF CIVIL ENGINEERS, at 8.—Durban Harbour, South Africa: C. W. Methven.—Natal Harbour Works: C. J. Crofts.

WEDNESDAY, FEBRUARY 12.

AERONAUTICAL SOCIETY, at 8.30.—The Law of Similarity connecting Models and Full-sized Machines: L. Bairstow.

ROYAL SOCIETY OF ARTS, at 8.—New Sources of Supply for the Manufacture of Paper: C. Beadle and H. P. Stevens.

THURSDAY, FEBRUARY 13.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* A Cassegrain Reflector with Corrected Field: Prof. R. A. Sampson. Studies of the Processes Operative in Solutions. XXV. The Influence of Non-electrolytes on Solubility. The Nature of the Processes of Dissolution and Precipitation: Prof. H. E. Armstrong and Dr. J. V. Eyre.—Studies of the Processes Operative in Solutions. XXVI. The Disturbance of the Equilibrium in Solutions of Fructose by Salts and by Non-electrolytes: E. E. Walker.—The Excitation of γ Rays by the α Rays of Ionium and Radiothorium: J. Chadwick and A. S. Russell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on Parallel Operation: A. R. Everest.

CONCRETE INSTITUTE, at 7.30.—Three Steel-frame Structures in London: S. Bylander.

ROYAL SOCIETY OF ARTS, at 4.30.—Kathiawar: Sir W. Lee-Warner.

MATHEMATICAL SOCIETY, at 8.—Figures in n-Dimensional Space analogous to Orthocentric Tetrahedra: T. C. Lewis.—A Property of the ζ-Function: J. E. Littlewood.—The Summability of a Fourier's Series. G. H. Hardy.—Trigonometrical Series which Converge Nowhere or almost Nowhere: G. H. Hardy and J. E. Littlewood.—A Theorem Concerning Power Series: H. Bohr.—The Theorem of Quadratic Reciprocity: P. J. Heawood.—The Irreducibility of Legendre's Polynomials: J. B. Holt.

FRIDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 9.—New Gyroscopes and their Applications: Prof. Andrew Gray.

PHYSICAL SOCIETY, at 8.—Annual General Meeting.—The Dynamics of Pianoforte Touch: Prof. G. H. Bryan.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.—Modern Condensing Systems: A. E. Leigh Scanes.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

MALACOLOGICAL SOCIETY, at 8.—Annual Meeting.

SATURDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson O.M.

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

NO. 2259, VOL. 90] THURSDAY, FEBRUARY 13, 1913 [PRICE SIXPENCE

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THURSDAY, FEBRUARY 13, 1913.

THE NERNST FESTSCHRIFT.

Festschrift W. Nernst zu seinem fünfundzwanzigjärigen Doktorjubiläum gewidmet von seinen Schülern. Pp. vi+487. (Halle a.d.S.: Wilhelm Knapp, 1912.) Price 21.60 marks.

THE present volume of scientific papers, dedicated to Prof. W. Nernst by his present and past pupils on the twenty-fifth anniversary of his promotion to the doctorate, is a splendid tribute to the success of Nernst as a great investigator and creator of investigators. It contains forty-four papers dealing with physicochemical subjects, many of them of great interest and importance. Their great variety forms a striking testimony to the extraordinary range and scope of the investigations which Nernst himself has personally carried out or directed and supervised.

Nernst's laboratory at Göttingen first became famous as a centre of electrochemical research, whilst at the present day his laboratory in Berlin is known all the world over as the headquarters of chemical equilibrium and affinity, not to mention molecular and atomic dynamics. His investigations have carried him from the ion of Arrhenius to the energy-quantum of Planck. Everywhere throughout this brilliant career the investigations of Nernst have been of fundamental importance for the growth and development of chemical and physical science. The science of physical chemistry in particular has reaped a bountiful harvest. The physical chemists of the world, in common with many other men of science, will therefore join heartily with Nernst's own pupils in congratulating him on the splendid work he has done, and in wishing him many years yet of successful scientific productivity.

It would be quite impossible in the space at our disposal even to enumerate, much less to describe in detail, the papers published in the *Festschrift*. This will be apparent when one recollects that it runs to nearly 500 pages. It must suffice, therefore, to indicate the nature of a few of the most interesting.

E. Abel has investigated the equilibrium (iodine-hydrolysis) $3I_2+3H_2O \rightleftharpoons 6H^{\cdot}+5I'+IO_3'$ in the presence of sodium acetate. In combination with the work of Sammet, the results obtained by Abel form one of the most extensive and searching verifications of the law of chemical equilibrium in aqueous solutions.

E. D'Agostino and G. Quagliariello discuss mathematically the curve of Log $[H^{\cdot}]$ as a function of the number of mols. acid or base added to a solution of a base or acid respectively, or to a solution of an amphotere. They show both theoretically and by practical numerical examples how the molar concentration, molecular weight, and dissociation-constants of a solution of an unknown acid, base, or amphotere can be deduced from such curves. Their method promises to be of great importance in dealing with proteids.

P. Askenasy and A. Solberg discuss the thermal decomposition of potassium permanganate. F. Bergius contributes an interesting paper on the formation and dissociation of calcium superoxide. Max Bodenstein and F. Kranendieck conclude from an investigation on the velocity of decomposition of ammonia in quartz vessels that the decomposition occurs in the pores of the quartz glass and is regulated by the diffusion of the ammonia into these pores.

K. Bornemann finds for the reduction-potential of hydrogen peroxide in aqueous solution $\epsilon_h = -0{\cdot}66 \pm 0{\cdot}03$ volt, and for the oxidation-potential $\epsilon_h = -1{\cdot}80 \pm 0{\cdot}03$. Both potentials are referred to that of hydrogen in a solution of the same $H^{\cdot}$-concentration.

A. Coehn and G. Grote contribute a long and valuable paper on the action of ultra-violet light on aqueous vapour and on electrolytic gas (hydrogen + oxygen).

R. Höber describes a new method of determining the inner electrical conductivity of blood cells. J. R. Katz applies Nernst's equation for "ideally concentrated" solutions to the phenomena of *Quellung*. Wl. Kistiakowsky gives an interesting account of the effect of motion on electrode-potentials and the phenomena of periodic passivity. F. Krüger discusses the formation of ozone by the silent discharge. F. A. Lindemann, in a most interesting paper, investigates mathematically the forces acting between the atoms of solid bodies. R. Lorenz gives an account of the present position of the question as to the electrolytic dissociation of molten salts. L. Michaelis discusses the iso-electric point of the "electro-amphoteric" colloids. E. and D. Müller determine the velocity coefficient of chlorate formation by an electrolytic method. N. Parravano and G. Sirovich discuss generally the phenomena of crystallisation in ternary systems. H. Pick contributes some interesting results on the molecular state and ionisation of aqueous solutions of hydrofluoric acid. R. Ruer and E. Scharff have investigated the effect of light on an anodically charged platinum electrode. O. Sackur discusses from a mathematical point of view the relation of the energy-quantum to the kinetic theory of gases and the calculation of Nernst's chemical constants.

G. Tammann discusses the effect of temperature on crystalline form. H. v. Wartenberg contributes some interesting data on the thermochemistry of silicon. F. Weigert has an important paper on the effect of oxygen in retarding and inhibiting photochemical reactions. It will be evident from this very brief summary that the Nernst *Festschrift* is full of interesting material and is in every sense worthy of the distinguished physical chemist in whose honour it was published.

F. G. DONNAN.

FUNCTION THEORY.

Lectures on the Theory of Functions of Real Variables. Vol. ii. By Prof. J. Pierpoint. Pp. xiii+645. (Boston, New York, Chicago and London: Ginn and Co., 1912.) Price 20s. net.

THE main topics of this volume are proper and improper integrals, series and products, point-sets and aggregates, continuity and discontinuity, and the geometrical notions derived from intuition. In style and method it follows the same lines as vol. i.

The first thing to notice is the substitution of "metric set" instead of "measurable set" for a set of points the upper and lower contents of which are equal. In chapter xi. we have the theory of the upper and lower measure of any set which can be enclosed by a countable aggregate of metric sets. The treatment is quasi-geometrical, after the manner of Minkowski, but, of course, all the arguments used are purely arithmetical. In this, as in all other parts of the subject, we are struck by the variety of cases presented by the strict arithmetical theory, where intuition suggests one definite conclusion. There are so many new symbols used that it is difficult to give an account of this valuable and original discussion of measure; it concludes with a theorem which may be regarded as an extension of the statement that, if a finite segment is divided into any finite number of parts, the length of the segment is the sum of the lengths of the parts. It is extremely interesting to compare the analytical theorem, and those which lead up to it, with the geometrical theorem, taken as obvious by all previous generations of mathematicians.

Another novel feature of the work is the author's definition of improper integrals. This is given on p. 32, after a statement of two other current definitions. It leads (pp. 402 *sqq.*) to a discussion of improper Lebesgue integrals, and an extended theory of the change of order of integration in a multiple integral. The theory of Fourier series is discussed from the same point of view, and we are thus led to see that the Fourier expansions are valid for cases which do not satisfy the conditions of Riemann and Dirichlet. Lebesgue, in fact, has made an addition to the theory of trigonometrical series so great that it ought not to be ignored in any treatise dealing with them with any attempt at completeness.

The sections which deal with geometrical conceptions are those which are likely to have the greatest educational effect upon the mathematical student. If we define an analytical curve by the equations $x=\phi(t)$, $y=\psi(t)$, where $\phi(t)$, $\psi(t)$ are one-valued continuous functions of a real variable t in a certain interval, then the curve is continuous, and, if closed, bounds a region in the plane (x, y). But it need not have a tangent at every, or any, point: it may fill up a plane area, such as a square, and no arc of it need have a finite length. Anything more remote from the conclusions of ordinary intuition it is hard to conceive. At the same time, all these statements have been proved with the utmost degree of rigour at present attainable, and seem to be proof against all possible objections.

In a similar way, the definition of the area of a surface as the limit of that of an inscribed polyhedron was shown to be fallacious by Schwarz (whose proof is reproduced on p. 626). The author gives a definition of the area, based upon the assumption $x, y, z=\phi(u, v), \psi(u, v), \chi(u, v)$, where ϕ, ψ, χ are functions of the independent real variables u, v, which range over a certain field. Thus we are brought back once more to Gauss's classical memoir as the first analytical treatment of surfaces destined to be of permanent value in the widest sense.

Practically, a good deal of the success of a mathematical treatise depends upon its symbolism. Dr. Pierpoint seems to have fairly hit the mark; his new symbols are not too many to remember, and each of them crystallises an important conception. Undoubtedly we shall have, before very long, a new and generally accepted system of symbols. At present we are in a state of comparative chaos, just as at the time of the invention of the infinitesimal calculus. The sooner this is ended the better; and it might be appropriately discussed by the next mathematical congress, if there is any prospect of agreement.

An Englishman naturally compares this work with that of Dr. Hobson. Dr. Pierpoint has the advantage of writing at a later date, and is thus able to include more recent discoveries; in other respects there is a contrast, which does not detract from the merits of either work, but is more or less typical of the nationalities of their authors. One abbreviates when he can, the other when he feels that he must; one tries to avoid metaphysics, but scarcely succeeds, while the other never touches on a metaphysical idea. Fortunately, philosophers are becoming more mathematical, and *vice versâ*; so the absorption of science and philosophy into poetry seems much less distant than a century ago. G. B. M.

A YEARBOOK OF SCIENCE.

Jahrbuch der Naturwissenschaften, 1911–1912. Edited by Dr. Joseph Plassmann. Pp. xvi + 452. (Freiburg im Breisgau and London: B. Herder, 1912.) Price 7*s*. 6*d*.

THE twenty-seventh volume of this useful publication is well up to the level of its predecessors. In spite of the great expansion of all the subjects treated, the size of the work has not been increased. This implies a more and more "intensive" treatment, and a careful selection of topics. In physics, the 5000 odd new publications of 1911 have been brought within the compass of forty-eight short notes. The task of selecting one paper out of every hundred must be a formidable one. Dr. Heinrich Konen, to whom it fell, took care to emphasise those which offer a certain amount of novelty or practical utility, such as Lebedef's shortest possible sound-waves (0·2 mm.), which are absorbed by $2\frac{1}{2}$ cm. of air; Rubens's longest light-waves (0·116 mm.); Féry's prism with curved surfaces; and Anderson's collodion copies of Rowland gratings.

The chemistry section is rather insufficiently separated from the industrial section, and so it happens that such things as the utilisation of zirconia, and the preparation of illuminating gas free from CO, are dealt with twice over. Dr. Plassmann himself writes the section on astronomy, and devotes considerable space to Martian questions and the mass of the ring of planetoids. Bauschinger's estimate of the latter, amounting to about one-fiftieth of the mass of Mercury, is supported on optical grounds.

Among the subjects dealt with in meteorology we find Wegener's stratification of the atmosphere, wind velocities, sunspots and weather, an aeronautical weather service, and Birkeland's theory of terrestrial magnetism and allied phenomena. The division of anthropology deals, among other interesting topics, with the origin of numbers and systems of culture, and the classification of human skulls. Other sections deal with mineralogy and geology, zoology, botany, agriculture and forestry, geography and ethnography, medicine and hygiene, aeronautics, and the various technical subjects. The latter include mechanical engineering, electrotechnics, heating and illumination, metallurgy, railway management, mining, ceramics, naval construction, freezing plant, gas industry, and firearms.

A calendar of astronomical events and an obituary complete the work, which may be regarded as an almost indispensable work of reference. It should be stated that it is printed in the Gothic type, and not in the Roman type now usual in German scientific publications.

GEOGRAPHICAL WORKS.

(1) *The Elements of Geography.* By R. D. Salisbury, H. H. Barrows, and W. S. Tower. Pp. ix + 616 + 7 maps. (New York: Henry Holt and Co., n.d.) Price 1.50 dollars. (American Science Series.)

(2) *A Geography of the British Empire.* By Prof. A. J. Herbertson and R. L. Thompson. Pp. 256 + 3 maps. (Oxford: Clarendon Press, 1912.) Price 2*s*. 6*d*. (The Oxford Geographies.)

(3) *Forfarshire.* By E. S. Valentine. Pp. viii + 160 + 2 maps. (Cambridge: University Press, 1912.) Price 1*s*. 6*d*. (Cambridge County Geographies.)

(4) *The Lost Towns of the Yorkshire Coast and other Chapters bearing upon the Geography of the District.* By T. Sheppard. Pp. xviii + 329. (London: A. Brown and Sons, Ltd., 1912.) Price 7*s*. 6*d*. net.

(1) THE American geography under notice emanates from members of the department of geography in the University of Chicago. British writers of geographical text-books have yet to follow German and American writers in work of this advanced character. The present volume forms, therefore, an interesting study, possessing many virtues and certain faults. The writers have followed general theoretical lines, avoiding those of the ancient "cosmography" with its principle of description according to countries.

After a short general discussion of the earth as a planet, and of its main features, we find a proper importance awarded to climate and weather, to which seven chapters are devoted out of a total of twenty-one. After these the authors deal with the oceans, then the "materials of the land" (soils, minerals, etc.), and lastly land-forms, with the consideration of the forces which shape them, and their influence on human conditions and on life generally. This is probably the best order that could be followed, though throughout the long section on climate there is some temptation to wish that a few more leading facts concerning the configuration of the surface and the other subjects of the later sections had been transferred to an introductory chapter, so that the student should be, at the outset, more clearly in possession of the exact meaning of the importance to be attached to the climatic factor.

A tendency observed in other American text-books is also to be noticed in this—that of introducing details which can scarcely be considered to have any relation with geography, even following the widest connotation of that term. The very close details of output in the economic chapters provide an illustration in point, valuable as they are, no doubt, in themselves. This book is very fully illustrated; many both of the diagrams and of the views are on too small a scale to fulfil their purposes properly.

(2) The "Geography of the British Empire," by Prof. Herbertson and Mr. Thompson, is arranged on a simple descriptive plan, and illustrated with a very large number of sketch-maps mostly showing very clearly the special points which they are intended to show, though not all are free from the charge of over-reduction. The book is of an elementary character, and little or no endeavour is made to deal with the inter-relation of the various parts of the Empire, though these are treated individually with a due sense of proportion. This proportionate treatment, within the compass of one volume, is in itself a valuable educational achievement, indicating what should be the first object of geographical teaching in British schools. It may be regretted, perhaps, that the coloured physical maps are confined to the representation of the British Isles.

(3) The Cambridge County Geographies have unquestionably improved since the inception of the series, and Mr. Valentine's volume on Forfarshire maintains the standard. In general reputation for scenic and kindred interests the eastern counties of Scotland have suffered in contrast with the western, yet Forfarshire is an area possessing many natural beauties, both on the coast and inland: its archæological interests are considerable, and its economic importance is high. All these aspects are clearly illustrated, both textually and by means of photographs, though the statistics freely quoted in the economic connection will not long maintain their value. The descriptions of ancient remains and buildings (for which Forfar is scarcely surpassed by any other Scottish county) are specially good.

(4) Mr. Sheppard provides a complete physical and historical setting for his study of the villages of Holderness which have been destroyed by the encroachment of the sea on the land. He cites authorities very fully, and has investigated old maps with great care; there is a chapter on these, with a number of reproductions, some of which have been reduced so far that not only the minutiæ, but also the more salient features, are lost; in such cases the reproduction of the pertinent section of the map on a larger scale would have been preferable. There are many appropriate photographs and reproductions of old prints. In one respect the title of the book does less than justice to its scope, for the last six chapters are descriptive of the East Riding generally, and will serve as a useful guide to that district.

The books by Mr. Valentine and Mr. Sheppard both contain, as it happens, an explanation of the word "shire"; the two writers curiously disagree on the point.

OUR BOOKSHELF.

Photography of To-day. By H. Chapman Jones. Pp. 342 + plates. (London: Seeley, Service, and Co., Ltd., 1913.) Price 5s. net.

THERE are a variety of text-books of photography in the market, one of which is by Mr. Chapman Jones. On turning to the work under review, to our great relief it is found to be of a totally different character from the ordinary variety. It contains no formulæ for developers or for anything else, but is what it professes to be—"a popular account of the origin, progress and latest discoveries in the photographer's art, told in non-technical language" and is illustrated with excellent illustrations of pictorial art, and with some passable diagrams. The author commences with light and its effects, then continues with lenses, and follows on with a short history of photography told in a bright and readable manner.

The history of photography before the use of gelatine is cut rather short, but perhaps it is well, as those who read the work will, as a rule, be those who use a Kodak—the "press the button and we do the rest" kind of people. To such photographers the chapters on the gelatine process will be read with pleasure, and will at all events enable them to talk rationally about their hobby, which is seldom the case at present, with few exceptions, and it may be that by reading it they may wish to "press the button" and do the rest themselves. The printing processes are fully described, as are instantaneous photography and telephotography. Truth and error in photography have a chapter devoted to them. There is a saying as to "lying like a photograph." Mr. Chapman Jones lets photography down easily in this respect.

The author has produced a book which it is a pleasure to read, and with some small omissions has carried out its intention admirably. Allusion has already been made to the illustrations, which are all distinctly good. It would have been interesting if he had told us the method adopted of reproducing the picture of the frontispiece, "A Rainbow from an Autochrome," in more detail than he does. We can recommend the book to all, more especially to those who are not expert photographers.

The Botany of Iceland. Edited by Dr. L. Kolderup Rosenvinge and Dr. Eug. Warming. Part i. "The Marine Algal Vegetation." By Dr. Helgi Jónsson. Pp. vi+186. (Copenhagen: J. Frimodt; London: John Wheldon and Co., 1912.)

Danish botanists are to be congratulated on the vigorous manner in which they attack the botany of the various dependencies of their kingdom. In the "Botany of the Faeröes" (1901–1908) the results of a systematic investigation of the flora and vegetation of those islands were presented, and with the completion of that work a similar survey of the botany of Iceland has been commenced.

The first part of the Iceland series, namely, the marine algæ, by Helgi Jónsson, has now appeared. It begins with the systematic list, which is concisely dealt with. An interesting account of the phytogeographic components of the flora follows, together with a comparison of the floristic features of neighbouring areas. The remaining pages are occupied with a detailed description of the algal communities, and notes on the biology of the species. A new method of classification is employed; three main vertical "zones" are recognised, and the communities of the littoral zone are subdivided according to their illumination requirements. It is open to question whether these divisions will meet with general approval, but all will agree that Dr. Jónsson has furnished a most valuable contribution to algological literature.

A. D. C.

A Medical and Surgical Help for Shipmasters and Officers in the Merchant Navy; including First Aid to the Injured. By W. Johnson Smith. Revised by Dr. Arnold Chaplin. Fourth edition, revised. Pp. xviii+355. (London: Charles Griffin and Co., Ltd., 1912.) Price 5*s.* net.

Dr. Chaplin has re-written the portions of the work dealing with the causation of diseases, so as to incorporate the recent advances in our knowledge, especially of tropical diseases. The new scales of drugs and medical and surgical appliances, issued by the Board of Trade in January, 1912, have been included, and in other ways the volume has been brought into line with present-day requirements.

A Handbook of Wireless Telegraphy: its Theory and Practice. By Dr. J. Erskine-Murray. Pp. xvi+442. Fourth edition. (London: Crosby Lockwood and Son, 1913.) Price 10*s.* 6*d.* net.

A review of the third edition of Dr. Erskine-Murray's book will be found in the issue of Nature for August 24, 1911 (vol. lxxxvii., p. 240). The additions to the present edition include a new chapter on the telegraphic efficiency of a wireless system; a theory of abnormal ranges, by night and by day, deduced directly from telegraphic observations, now included in the chapter on transmission; and new sections in other chapters on the Poulsen, Goldschmidt, and new Telefunken systems.

LETTERS TO THE EDITOR.

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

On the Appearance of Helium and Neon in Vacuum Tubes.

At the last meeting of the Chemical Society, Sir William Ramsay, Prof. Collie, and Mr. Patterson described some experiments which they regard as proving the transmutation of other elements into helium and neon. I have been making experiments of a somewhat similar character for some time, and though the investigation is not yet finished, the results I have obtained up to the present time seem to me in favour of a different explanation from that put forward at the Chemical Society. I described some of these experiments in a lecture at the Royal Institution on January 17, but as the separate copies of that lecture have not yet been issued, I will give here an account of some of the experiments which seem to me to have the most direct bearing on the phenomenon in question.

I used the method of positive rays to detect the gases; this method is more sensitive than spectrum analysis, and furnishes much more definite information. I may say that the primary object of my experiments was to investigate the origin and properties of a new gas of atomic weight 3, which I shall call X_3, which I discovered by the positive-ray method. This gas, as well as one with an atomic weight 20 (neon?), has appeared sporadically on the photographs taken in the course of the last two years; the discharge in the tube being the ordinary discharge produced by an induction coil through a large bulb furnished with aluminium terminals, and containing gas at a very low pressure. There seems to be no obvious connection between the appearance of either of these lines and the nature of the gas used to fill the tube; the 3 line has appeared when the bulb was filled with hydrogen, with nitrogen, with air, with helium, or with mixtures of hydrogen and oxygen in various proportions; the 20 line when the bulb contained hydrogen, nitrogen, air, hydrochloric acid gas, mixtures of hydrogen and oxygen.

The experiments I made had for their object the discovery of the circumstances which favour the production of X_3, and to test whether it was triatomic hydrogen produced by the discharge, as this is the alternative to its being a new element. I have found that the conditions which lead to a considerable production of X_3 generally give rise to the appearance of helium and neon. Indeed, in the great majority of cases in which I have observed the appearance of traces of helium and neon these gases have been accompanied by larger quantities of X_3; this gas seems to have escaped the notice of the readers of the paper at the Chemical Society. I may mention, too, that along with neon of atomic weight 20 there is a line in these circumstances corresponding to an atomic weight 10 or thereabouts. Though this is probably due to neon with two charges of electricity, it is generally brighter in comparison with the neon line than is usual for the lines corresponding to doubly and singly charged atoms, so that it is not impossible, though perhaps unlikely, that it may be due to a new gas.

The positive rays for the analysis of the gases were produced in a vessel containing gases at a low pressure. I shall call this the testing vessel; the vessel in which the various processes for generating X_3

were tried (the experimenting chamber) was sealed on to the testing vessel, but separated from it by a tap. Thus the pressure in the experimenting chamber was not restricted to being the same as that in the testing vessel, but might have the value which seemed most appropriate for any particular type of experiment. After these experiments were over, the tap was turned and some of the gases from the experimenting chamber let into the testing vessel; a photograph was then taken, and by comparing it with one taken before turning the tap the new gases present in the experiment chamber could be detected. The processes by which I have hitherto got the most plentiful supply of X_3 are:—

(1) By bombarding with kathode rays metals and other bodies.

(2) By the discharge from a Wehnelt kathode through a gas at a low pressure.

(3) By an arc discharge in a gas at a comparatively high pressure.

By far the larger number of the experiments were made by bombarding metals, but I will begin by describing an experiment with the arc, as it raises the question of the origin of these lines in a very direct way. An arc between iron wires passed through hydrogen at about 3 cm. pressure (in this case all the kathode rays would be absorbed quite close to the electrode) for an hour or so, and the gases liberated in the experimenting chamber tested; X_3, helium, and neon were found. The experiment, using the same wires for terminals, was repeated the next day; the three gases were again found. On the next day, still using the same wires, the arc was passed through oxygen; the X_3 line was still there, though much fainter than before; the helium and neon could not be detected with certainty. The next day, using the same terminals, the arc was again passed through oxygen; not one of the lines could be detected. This looks as if these substances were produced by the arc passing through hydrogen. It was found, however, that, still keeping to the same terminals, on pumping the oxygen carefully out and filling up again with hydrogen, the arc through the hydrogen now did not give even a trace of these lines. On replacing the old iron wires by new ones, and sending the arc through the hydrogen, the lines reappeared. This experiment seems to me to point very clearly to the conclusion that these gases were in the terminals to begin with, were removed from them by the long-continued sparking, and were not produced *de novo* by the arc.

In the experiments when the discharge was produced in a tube with a Wehnelt kathode, the potential difference between the terminals was only 220 volts, so that the kathode rays in the tube had only a fraction of the energy they had when the discharge was produced by an induction coil; X_3 and helium appeared when the discharge passed through this tube. I did not detect any neon.

The method which gave X_3 and also the other gases, in the greatest abundance, was to bombard metals, or indeed almost any substance, with kathode rays. The tube used for this purpose had a curved kathode, which focussed the rays on a table on which the substance to be bombarded was placed. The substance, round the spot struck by the rays, was generally raised to a bright red heat by the bombardment; the bombardment was as a rule continued for five or six hours at a time. I have got the X_3 line, as a rule, accompanied at first by the helium line, and somewhat less frequently by the neon line, when these following substances (which include nearly all I have tried) were bombarded: iron, nickel, oxide of nickel, zinc, copper, various samples of lead, platinum, two meteorites, and a specimen of black mica given me by Sir James Dewar, which was remarkable for the amount of neon it gave off.

The most abundant supply of X_3 came from platinum, and I will describe an experiment with this metal. A piece of platinum foil was bombarded on four days, and the gases produced each day examined. At the end of the first day's bombardment it was found that the line due to X_3 was very strong, those due to helium and neon weaker, but still quite conspicuous. The gases produced the first day were well washed out of the tube, and the foil bombarded for a second day. The gases formed proved to be much the same as on the first day; there was no appreciable diminution. The examination of the result of the third day's bombardment showed that the X_3 line had diminished considerably, the lines due to helium and neon perceptibly. When the gases produced on the fourth day's bombardment were examined it was found that the X_3 and helium had diminished to such an extent that the lines were barely visible. I could not see the neon line at all. In this case the helium was not eliminated until the fourth day. In general I have found that the helium disappeared long before the X_3 gas. Thus a piece of old lead I bombarded gave off appreciable quantities of helium from the first day's bombardment, very little on the second day, and none that I could detect on the third or subsequent days. The X_3, on the other hand, came off in considerable quantities up to the end of the experiment, which lasted for six days. I attribute the superior elimination of X_3 in the case of the platinum foil to the fact that during the whole time the bombardment was concentrated on a patch only about 2 mm. in diameter, while the lead melted under the bombardment, so that fresh portions were continually being exposed to the rays. A piece of Kahlbaum's chemically pure lead gave appreciable amounts of X_3 and helium, though not nearly so much as the old lead. I tried some lead which had just been precipitated, but could not detect either X_3 or helium.

In the course of the experiments with old lead I let hydrogen into the experimenting chamber to see if it would increase the amount of X_3, but could not detect any effect. On one occasion I let in oxygen when nickel was bombarded, also without any appreciable effect. I think these experiments are in favour of the view that these gases are present in the metal independently of the bombardment, and are liberated by the action of the kathode rays. They are surprisingly firmly held by the metal, and cannot, so far as my experience goes, be got rid of by heating. I kept a piece of lead in a quartz tube boiling in a vacuum for three or four hours, until all but a quarter of the lead had boiled away, and examined the gases given off during this process; neither X_3 nor helium could be detected. I then took the quarter that remained and bombarded it, and got appreciable amounts of X_3 and helium. On a second bombardment the X_3 was visible but the helium had disappeared. As an instance of the way these gases can stick to metals even when in solution or chemical combination, I may mention that though, as I have said, platinum foil after long exposure to kathode rays is freed from these gases, yet I got appreciable quantities of X_3 and helium, though no neon from platinum sponge freshly prepared from platinic chloride.

The reason helium is obtained by heating the glass of old Röntgen-ray bulbs is, I think, that after liberation by the kathode rays, the helium either adheres to the surface or is absorbed in a much looser way than before it was liberated. The question as to how these gases get into the metals is a most interesting one; are they absorbed in the process of manufacture?

In this connection it is interesting to note that X_3 does not appear to occur to any appreciable extent in the atmosphere. Sometimes when suffering from the difficulty of clearing out these gases I have been goaded into speculating whether they do not represent the partially abortive attempts of ordinary metals to imitate the behaviour of radio-active substance; but whereas in these substances the α particles and the like are emitted with such velocity that they get clear away from the atom, in ordinary metals they have not sufficient energy to get clear, but cling to the outer parts of the atom, and have to be helped by the kathode rays to escape.

I would like to direct attention to the analogy between the effects just described and an everyday experience with discharge tubes—I mean the difficulty of getting these tubes free from hydrogen when the test is made by a sensitive method like that of the positive rays. Though you may heat the glass of the tube to melting point, may dry the gases by liquid air or cooled charcoal, and free the gases you let into the tube as carefully as you will from hydrogen, you will still get the hydrogen lines by the positive-ray method, even when the bulb has been running several hours a day for nearly a year. The only exception is when oxygen is kept continuously running through the tube, and this, I think, is due, not to lack of liberation of hydrogen, but to the oxygen combining with the small quantity of hydrogen liberated, just as it combines with the mercury vapour and causes the disappearance of the mercury lines. I think this production of hydrogen in the tube is quite analogous to the production of X_3, of helium, and of neon. I have been greatly assisted in the experiments I have described by Mr. F. W. Aston, Trinity College, and Mr. E. Everett. J. J. THOMSON.

February 8.

The Water-surface "Halo."

THE "halo" which a happy memory of eighty years enables the Rev. O. Fisher to recall in NATURE of February 6 was probably one to which the explanation offered by Dr. Franklin Parsons does not apply.

There is a very striking phenomenon of separate rays or shafts of light converging on the shadow of the observer's head when this shadow is thrown on water. The phenomenon requires for its production certain conditions:—(1) A bright sun, high in a clear sky. For this reason in these latitudes the appearance is best seen about midday in summer. In winter it is scarcely noticeable. (2) The water must not be quite clear; on the other hand it must not be very turbid. (3) The surface must not be smooth, but may be fairly briskly agitated, but again not too briskly. (4) The water should be deep.

If any one of these conditions is absent the phenomenon is not seen, or is only imperfectly seen, as I was able to satisfy myself about twenty-five years ago by observations made, day after day, on the lake of Ullswater, where a stream discharged the muddy water of a mine far into the lake, and thus provided one of the necessary factors of variation. The necessity of these conditions, when once discovered, makes the explanation easy. The irregular convexities of the ruffled surface acting as condensing lenses separate the light penetrating the water into converging shafts. Along certain lengths of each or many of these shafts a sufficient condensation of light takes place to render them visible by means of the additional illumination of the slight turbidity. Thus the water is filled with luminous parallel shafts of varying lengths, which, seen in perspective, have their vanishing point in the shadow of the observer's head. I remember that it was long before I realised that the rays were *below* and not *on* the surface. When the observer's head is not many feet above the water the rays may be traced to great distances—50 or 60 degrees—from the shadow of the head.

The phenomenon, though often very brilliant, is often unnoticed, even by good observers—I think because it requires a certain comprehensive glance, no doubt in the first instance accidental, to recognise that the widely separated broken radiations belong to a single convergent system. But when this system has once been realised it becomes hauntingly present, and one glimpses portions of it at every glance at the water, even though the shadow of the head is cut off from the surface. A. M. WORTHINGTON.

Exmouth, February 9.

An X-Ray Fringe System.

BY allowing a diverging pencil of Röntgen radiation to fall at nearly grazing incidence on one of the sets of cleavage planes of a crystal of rock-salt, and observing the intensity of the reflected pencil by a photographic plate, we find a series of well-marked and equal-spaced maxima in positions corresponding to equal increments of $\cos\theta$, where θ is the angle of incidence of radiation on the cleavage planes. In the directly transmitted beam there is no indication of variation of intensity with angle of incidence We thus have what *appears* to be a series of X-ray spectra of different orders, due to agreement in phase of waves from successive layers of molecules. Calculating on this assumption we get a wave-length of the order of magnitude in agreement with that calculated from the velocity of ejection of electrons by a substance exposed to this particular radiation—that is, assuming the results of the experiments of A. L. Hughes and others on ultra-violet light are equally applicable to Röntgen radiation. While only few experiments have yet been made on which to base any interpretation, this is in agreement with what we have already observed. Of the experimental results there is no doubt, and we cannot at present suggest any probable explanation except the very obvious one of interference. Further experiments are in progress.

C. G. BARKLA.
G. H. MARTYN.

King's College, London.
February 11.

Atmospheric Potential.

IN NATURE of December 12, 1912 (p. 411), Dr. George C. Simpson directs attention to several outstanding problems in atmospheric electricity. He says, *inter alia*: "Everywhere it has been found that the air is a conductor, and that the potential gradient is practically the same." It is not the object here to consider these statements, however questionable.

The potential gradient of the atmosphere is the difference of electric potential between two points in the same vertical one metre apart; which, for the first few kilometres above the earth's surface, is about 100 volts.

Now one problem which Dr. Simpson does not mention is the absence of current from the upper regions of the atmosphere to the lower corresponding to this difference of potential between them. It is a fundamental law of electricity that an electric current will flow in a conductor from a high potential to a lower one.

A conductor projecting vertically from the earth's surface into the atmosphere for a distance of only ten metres would give for the first metre a voltage of 100, for the second 200, for the third 300, and so on, each voltage tending independently to send a current to the lower end of the conductor. So that a total voltage of 5500 would operate to send a current through the end of a conductor ten metres in height. By the same rule, a voltage mounting into the billions would operate to produce a current in a conductor reaching up to the top of a mountain two or three miles high. Yet there is no corresponding current, if indeed any at all. However poor the air may be as a conductor in transmitting the voltage, it would seem that winds would keep it stirred so as to have fresh portions of it continually in contact with the wire, and so cause a continuous current along it.

I know that others besides the writer would be grateful for some explanation of this apparent paradox. EVAN M'LENNAN.

Corvallis, Oregon, U.S.A., January 14.

The Upper Trade and Antitrade Winds.

THE table published by Dr. van Bemmelen in NATURE of October 31, 1912 (p. 250), on an atmospheric sounding over Batavia up to a height of 30,800 metres, compared with Dr. A. Wegener's diagram of gases constituting the atmosphere, reveals a striking connection of the succession of the principal wind-drifts with the principal boundary-plains of the atmosphere.

(1) The surface of the pure nitrogen and oxygen atmosphere, almost free from hydrogen, is situated at a height of nearly 23 km.

(2) The surface of the troposphere is, between the tropics, situated at a height of nearly 17 km.

(3) The third principal surface is situated nearly at 0 km.

The table of the sounding of September 12, 1912, shows over each of these heights a succession of winds having a distinct trade and antitrade character.

Over surface (1), about 24 km., the direction from S_4E, above 25 km., the Krakatoa winds from $E_{21}E$ to $E_{31}N$. Over surface (2), about 18 km., the upper trade from E_8S to $E_{42}S$, above 19 km., the high westerly winds from $W_{17}S$ to $W_{30}N$. Over surface (3) the common trade from S to E_4N, above 4 km., the antitrade from E_{20} to $E_{54}N$.

The formal agreement is more perfect between the wind-directions over (1) and (3); but in any case, the directions over (2) confirm the German proverb: "Die Ausnahme bestätigt die Regel." For the directions from E_8S to $E_{42}S$ (average $E_{25}S$) are clearer trade-directions, and from $W_{17}S$ to $W_{30}N$ (average W_1N) are clearer antitrade-directions than the directions over surface (1) and surface (3).

This being so, it seems to be useful to compare the averages of these atmospheric layers in a table:—

Heights, km.	Averages: Of simple wind-directions	Of wind forces	Of air-transports	Wind-drifts of atmosphere	
25–30·5	$E_{18}N$	20	E_8N	Krakatoa winds	1
24	$E_{51}S$	8	$E_{81}S$	High trade-winds	
19–23	W_1N	12	W_4N	High westerly winds	2
17·5–18	$E_{25}S$	4	$E_{46}S$	Upper trade-winds	
4–17	$E_{24}N$	12	$E_{28}N$	Antitrade-winds	3
0–3	$E_{29}S$	4	$E_{34}S$	Trade-winds	

There is a striking agreement of layers (1) and (2) as regards the averages of wind-forces, and a better agreement regarding the real air-transports (averages of directions × forces) than the simple wind-directions.

Here I should like to correct an erratum in the letter of Dr. van Bemmelen, vol. xc., p. 250. The antitrade is in the dry season situated *lower* instead of *higher* (compare vol. lxxxvii., p. 415).

WILHELM KREBS.

Holsteinische Wetter- und Sonnenwarte, Schnelsen, January 9.

Nomenclature at the Zoological Congress.

CERTAIN proposals regarding zoological nomenclature, circulated by Dr. Franz Poche, of Vienna, and supported by many zoologists, may be worth discussing in the columns of NATURE. An appeal has been made to zoologists in general, because it has proved difficult to get matters submitted to the Zoological Congress through the Commission on Nomenclature owing to the rule that permitted a single member of the commission to block progress in this direction if he so desired. It is therefore proposed that propositions for the amendment of the existing rules must be submitted to the congress if they have been approved by a majority of the commission. There can be little doubt that this plan will receive the support of the congress, and in the absence of anything better, I have willingly voted for it. It must be acknowledged, however, that the vote of the congress, in open session, may not always represent the best considered opinions. I was present when the proposals of the Commission on Nomenclature were submitted to the Zoological Congress at Boston, and it seemed evident that the time and place were ill-suited for the careful consideration of the subject. The commission had, indeed, held a special session during the congress, to which all zoologists were invited, but the attendance was sparse and not very representative.

At the coming congress at Monaco, owing to the change of date, it is probable that few Americans will be present, and probably many others, who are teachers, will be unable to leave their classes in the midst of the spring term. The plenum vote is therefore likely to be even less representative than usual; but, on the other hand, the active discussion of the last few years will undoubtedly stimulate more intelligent and widespread interest than was manifested at Boston. Is it not possible to adopt an entirely different and more representative plan, which will give all the results desired by Dr. Poche and his supporters? Why not circulate in advance the arguments for and against proposed amendments, prepared by prominent representatives of the two sides, and then reach a decision by votes received through the mails? Each country could be assigned a certain number of voters, according to its zoological strength; or it would perhaps be simpler to permit all those to vote whose works had been cited in as many as five different issues of *The Zoological Record*. In this way we should obtain a very accurate representation of zoological opinion throughout the world, every zoologist of any long standing having a vote, and all having plenty of time carefully to consider the questions involved. In the long run, the majority of working zoologists will have their way, and it will be a great saving of time and annoyance to permit them to do so as soon as possible. The same method could be adopted by the Botanical Congress, where it is perhaps even more needed, owing to the less settled state of botanical nomenclature.

A second of Dr. Poche's proposals relates to generic names published by authors who do not apply "the principles of binary nomenclature." Some of the decisions of the commission on this question have seemed to many of us contrary to the true meaning of the rules as they now stand, and so as unnecessary as they are injurious.

A third proposal has to do with the method of determining generic types, and virtually substitutes elimination for type designation. This seems to me a backward step, and those who have used the "elimination" method know well how uncertain and difficult of application it is. On the other hand, the existing rule is not wholly satisfactory. I have elsewhere proposed that when, owing to the discovery of some long-forgotten type designation, a well-known generic name is in danger of being applied in an entirely unaccustomed way, the commission, with the approval of the congress, may arbitrarily designate a type from among the originally included species, in such a way as to retain the current usage of the generic name. It might further be recommended that no one should change the significance of a well-known generic name on account of some old designation of type, without first submitting the case to the commission.

The perplexities of nomenclature are many, doing the best we can, and they should not be needlessly increased. It is even a question whether the writer of these lines really belongs to the species *Homo sapiens*. The "typical" *sapiens*, as described by Linnæus and restricted by D. S. Jordan, is an imaginary being, "tetrapus, mutus, hirsutus," clearly not conspecific with our modern man. Possibly, according to strict nomenclatural rules, the present writer is *Homo americanus europaeus* (L.).

T. D. A. COCKERELL.

University of Colorado, Boulder.

The Discovery of a Human Tooth in the Cave Earth in Kent's Cavern.

IT will be remembered by those interested in the exploration of Kent's Cavern that during the course of the sixteen years' examination of the cavern-deposits, no vestige of the human skeleton was found under the upper stalagmite, though, as mentioned in your columns a few weeks ago, a portion of a human jaw was found *in* the upper or granular stalagmite.

On Saturday evening, February 1, I received the following communication from Mr. Charles Cox, who, with Mr. Powe, the owner of the cavern, has been making additional explorations:—

"Perhaps you will be interested to know that while digging inside arched entrance . . . on January 23 found *human* tooth, and a few minutes after a passage that proves to be the opposite end to the passage found on June 20 last. The above human tooth was 15 in. deep in undisturbed cave earth. Allowing 4 ft. previously excavated, it would be 5 ft. 3 in. below granular stalagmite floor.

"Faithfully yours,

"(Signed) CHARLES COX."

"A. R. Hunt, Esq."

On Monday, February 3, I went to the cavern and saw the spot where the tooth was found, and then went to Mr. Cox's residence, Cavern Villa, to see it. The tooth is an upper incisor, very much worn, and evidently sharpened on the under teeth to a chisel edge.

The points which struck me, as a non-expert, were the triangular shape and the convex front profile of the tooth. A medical friend points out that the triangular shape would be due to much wear on edible roots, &c.

It is to be regretted that the tooth is not a molar; but even as an incisor it seems to attest its own antiquity. It is a remarkable fact that the British Association Research Committee, by restricting its excavations to 4 ft., missed the tooth by 15 in., and the two ends of the passage referred to by Mr. Cox (one end in the sloping chamber and the other far away, near the arched entrance) by little if anything more!

I think it may be useful for me to make this statement (of course, with Messrs. Powe and Cox's consent) as one well acquainted with Kent's Cavern.

ARTHUR R. HUNT.

Southwood, Torquay, February 5.

THE BRITISH ANTARCTIC EXPEDITION.

THE British nation has been overwhelmed with grief by the news that when but a small fraction of their journey remained to accomplish, Captain Robert Falcon Scott and those who accompanied him to the south pole met their death. For the pole had been reached—the position doubly assured by the discovery of the marks left there by Amundsen—and it was only on the return journey, 155 miles from their headquarters, that nature turned relentless, and heaped such a load of difficulties upon the travellers that they finally perished.

Until the vessel *Terra Nova* came into touch with means of communication in New Zealand on Monday last, on her return from the Antarctic, we knew the story of the expedition only down to the early part of last year. The ship had left London on June 1, 1910, for her first outward voyage. The expedition, as perfect in organisation and equipment as not only Scott's former experience, but that of brother-explorers, willingly afforded, could make it, included a larger scientific staff than had ever before been taken south, for this was no mere polar dash. McMurdo Sound was reached, after a difficult voyage from New Zealand, in December, and the main party was landed, to establish headquarters at Cape Evans. A smaller party was placed on the west side of the Sound, and another, which had been destined for King Edward VII. Land, was prevented from landing there by the ice, and was put ashore at Cape Adare. This last party, by the way, must have had difficulties to face only less severe than those of the main body: they encountered heavy weather from the outset, and after being taken off by the ship early last year and landed again at Terra Nova Bay, Victoria Land, they had to be left there instead of being brought off before the ship returned to New Zealand; and it is only now that we learn that, under Lieutenant Campbell's leadership, they wintered in a snow-hut, living on seals and little in the way of imported provisions, were overtaken with sickness, and only regained headquarters in the early part of last November.

When the ship brought back the news of the party down to January, 1912, and it was learnt that Scott was to remain another year to complete his tasks, there was already ample evidence that the scientific workers had justified themselves under the general direction of Dr. E. A. Wilson, whose loss, along with his leader, is now mourned. At headquarters regular temperature, pressure and wind observations had been kept up, and balloon work had been carried out for the study of the upper atmosphere—an investigation new in antarctic research. Magnetic, gravity and tidal observations, the study of the ice and biological and geological investigations had also been made. Wilson himself, desirous of studying the winter breeding of the emperor penguin, had led a short expedition to Cape Crozier, very noteworthy from the fact of its having been made in June, July and August (winter).

Meanwhile the work of laying depôts for the march to the pole had been carried out, and the march itself was begun on November 2, 1911. Scott had lost nearly half his ponies, and, anxious not to risk the remainder further than absolutely necessary, he delayed the start of the march for a month. In his last message he designates that as a contributory cause of the disaster. Almost from the outset the season appears to have been bitterly unfavourable. However, last year's last message showed the polar party going well, within 150 miles of the pole, where it was left by Commander Evans, Scott's second in command, who brought back the news.

And now the story is taken up by Scott himself, within a few hours of death. His diary is an imperishable memorial, not only of a struggle against overpowering odds at the moment, but of the foresight which was so essential a characteristic of his work. For in face of the foreknowledge of the inevitable end, he looked beyond it to the reception of the news by the world, nearly a year later; fighting against the last weakening, he set down a clearly reasoned statement of the causes which had led to the disaster—misfortunes, he calls them; he will not allow any charge of faulty organisation to be laid against himself and his helpers. Their thoughts turned at last to those dependent on them, and these Scott commended to the assistance of the nation in terms which will be forgotten by none who reads them.

The pole had been reached on January 18, 1912. Scott's companions were Dr. E. A. Wilson, Captain L. E. G. Oates, Lieutenant H. R. Bowers, and Petty Officer Edgar Evans. The last, who was believed to be the strongest man of the party, was the first to break down and delay the rest. The conditions of going on Beardmore Glacier were extremely severe, and here at last (February 17) Evans suffered concussion of the brain, which hastened his end. Then on the Barrier the weather conditions suddenly changed for the worse, with very low temperatures and high winds. Captain Oates fell gravely ill; Scott notes a shortage of fuel in the depôts. On March 16 Oates, feeling death upon him, and knowing that he held his companions back, went from them to meet it. Scott, Wilson, and Bowers pressed on, but within eleven miles of one of the depôts (which was afterwards found by the relief party in good order) a blizzard fell upon them. They had food for two days; Scott wrote his last message when they had been imprisoned for four. A relief party had been out for them; it appears to have been not very far, in either time or distance, from gaining its end. But the remains of Scott and his two companions were not found till after the ensuing winter, in November last.

This is the end of a great explorer: a man *omni consensu capax imperii,* and capable, moreover, of inspiring his followers with affection as well as enthusiasm, of judging the worth of men, and of making the best of their abilities. We find not only that men who accompanied him on his first journey to the south in 1901, as Wilson did, were ready to accompany him again on his second, but also that his inspiration helped others to enter the field independently, as Shackleton did, and already Dr. Charcot has placed it on record that it was Scott who "opened the road to the pole." Such honour, by itself, might have been held to be scientifically barren, but the gains to science of Scott's first journey, supplemented by what is known of the results of the second, refute any possible charge that he aimed merely at the breaking of a record. It has been said of him that he must have risen high in his profession, and indeed, considering how much of his life was devoted to the Antarctic, he did so. Born at Devonport in 1868, he was in the *Britannia* as a naval cadet in 1881, and afterward served successively on the Cape station, in the Channel and Training squadrons, and on the Pacific station, before specialising as a torpedo lieutenant. He was promoted commander in 1900. On his return from the Antarctic in 1904 he was promoted captain, besides receiving the C.V.O. and many other honours, including the Royal medal and a special medal from the Royal Geographical Society, the body which has throughout been most closely associated with his exploring work. In the course of naval service between his southern journeys, he was at the Admiralty as Naval Assistant to the Second Sea Lord.

Dr. E. A. Wilson, as has been said, was chief of the scientific staff; in the former expedition he had served as artist and zoologist on vertebrates. He was an *alumnus* of Cheltenham College and Caius College, Cambridge. Captain Oates was of the 6th (Inniskilling) Dragoons; he served with distinction in the South African war, and on the present expedition his special charge was that of the ponies and mules. Lieutenant Bowers was commissariat officer of the southern party, and Evans was a tried antarctic traveller, having served on Scott's first expedition.

The nation has reason to be proud of these men, who have laid down their lives in the pursuit of geographical knowledge; and it will respond generously to Scott's last appeal: "Surely, surely a great, rich country like ours will see that those who are dependent upon us are properly provided for."

EYESIGHT AND TYPOGRAPHY.[1]

THIS report of the British Association Committee on the influence of school-books upon eyesight is full of interest. Its value depends chiefly upon the report of the oculist subcommittee, which was composed of Messrs. Priestley Smith, H. Eason and N. Bishop Harman. Advice upon the technical and trade aspects of printing was given by competent experts.

The subcommittee's report is valuable from the immediate point of view of school-books and also from the point of view of the reading of printed matter in general. Considering the enormous importance of reading and writing to the general public and the large place they occupy in daily life, it is remarkable that so little attention has hitherto been devoted to the physiological and hygienic features of the subject. It would have been a gracious act for the subcommittee to have expressed its indebtedness to the researches of Javal, an indebtedness which is unmistakable. With few exceptions the report recommends the principles advocated by Javal, and the authors have, perhaps wisely, refrained from any experimental researches on their own account. The subject is full of complications, physiological and psychological, and the recommendations made are as good as can be expected in the present state of knowledge.

At the outset of the section on the hygienic requirements the right note is struck in emphasising the fact that the reader recognises whole words and phrases at a glance. This statement expresses the essential difficulty of the scientific investigation and regulation of printing. Too much stress cannot be laid upon the fact that the canons of *visibility* of individual letters do not apply directly to the far more complex problem of the *legibility* of letter groups in words and phrases. It is rightly pointed out that the upper half of a word or letter is usually more important for perception than the lower half. We would emphasise the point more strongly. It is the fundamental factor in legibility, as is easily proved by reading with the lower half of the line covered by a card. Hence we think that the suggestion made to give more distinctive character to the lower half of a larger proportion of letters is unsound.

The general evolution in the shapes of printed letters has been in the direction of increasing the predominant features of the upper halves, so that more letters extend above the line than below, the extension above the line has increased, whilst that below has been curtailed, and so on. These tendencies are in favour of legibility and should not in our opinion be tampered with. For the same reason we are astonished at the statement that "uncial Greek may be recommended as being easy to read (see supplement)." The supplement gives two examples, one in 12-point Porson Greek, the other in uncial Greek on long primer body. A glance suffices to show that the former is much more legible.

Owing to the complexity of the correlation of the physiological and psychological factors in reading, such details as the best dimensions of letters and spacing, length of lines and their separation, and so on, are at present matters of compromise. The committee does not give any explicit scientific reasons for the faith that it has, but the typographical table and the rules laid down are eminently sensible. The small type used in Bibles and prayer-books is more than a matter of regret; we should like to have seen it more severely condemned. The remarks on the thorny question of atlases are very good.

We hope that this report will have a widespread influence. It contains much sound advice not only for those who deal in school-books but for all authors and publishers.

[1] Report on the Influence of School-books upon Eyesight by a Committee of the British Association, presented at the Dundee Meeting, 1912. Copies obtainable from the British Association, Burlington House, London, W. Price 4*d*.

INVESTIGATION OF ATMOSPHERIC POLLUTION.

THE Committee for the Investigation of Atmospheric Pollution, appointed at the International Smoke Abatement Conference and Exhibition held in London last March, has held three meetings in London and has just published what may be regarded as an interim report.

This report states that after careful consideration of all the various methods that have been suggested or tried for measurement of the impurities of the atmosphere, that employed for *The Lancet* investigation of the soot and dust-fall of London in 1910 has been selected as the simplest, and the one most likely to yield satisfactory results under the conditions which will govern the observations that are to be made. The method is based upon the use of an apparatus resembling an enlarged rain-gauge, with a catchment area of 4 sq. ft. This gauge receives all the dust and soot that falls by its own weight or is carried down by the rainfall during the period of its exposure, and on examination of the water which collects in the bottle attached to the apparatus, the amount of total suspended matter, tarry oils, soot, &c., can be determined.

A circular letter has been sent out by the committee to all the more important city and local authorities in the United Kingdom, asking for their cooperation in the application of this method of observation in the districts over which they have administrative powers. This circular has met with a most gratifying response. The authorities of a large number of important cities have already signified their intention of commencing observations on the lines suggested by the committee, and many other authorities are only waiting for further details before promising their support to the movement and cooperation in the work. Birmingham, Bradford, Leicester and Newcastle are the most important of the cities that have definitely promised their support; but there is no doubt that Glasgow, Liverpool, Manchester and London will join in these observations.

The new movement initiated by the committee for studying and recording the character of the soot-fall in various industrial centres of the United Kingdom is, therefore, meeting with considerable support; and there is little doubt that the observations and records will prove of decided value to all interested in the progress of smoke abatement.

Dr. W. N. Shaw, F.R.S., director of the Meteorological Office, is chairman of the committee; and its hon. secretary is Dr. J. S. Owens, 47 Victoria Street, S.W., from whom any further particulars regarding the work of the committee can be obtained.

LORD CRAWFORD, F.R.S.

AS announced with regret last week, James Ludovic Lindsay, the twenty-sixth Earl of Crawford, died on January 31. Born at St. Germain-en-Laye on July 28, 1847, he was educated at Eton and Trinity College, Cambridge, and for a short time served as lieutenant in the Grenadier Guards, but his early developed scientific tastes led him to resign the service and devote himself to astronomy and bibliography.

As Lord Lindsay he first became known to readers of NATURE by his organisation of an expedition to observe the total eclipse of the sun near Cadiz on December 21, 1870, and by the establishment, soon afterwards, of his observatory at Dun Echt, Aberdeenshire. Its astronomical equipment was far in advance of any other observatory in Scotland and second only to that of Greenwich in the United Kingdom, for it contained a fine 15-inch equatorial refractor by Grubb with many improvements on former designs, a transit circle of 8-in. aperture by Troughton and Simms, a fine heliometer by Repsold of 4-in. aperture, a 6-in. equatorial refractor by T. Cooke and Sons of York, two reflecting telescopes with silver-on-glass mirrors of 12-in. aperture, both equatorially mounted, a Foucault siderostat by Eichens of Paris, with 16-in. mirror by M. Martin, a 40-ft. photographic lens by Dallmeyer (to be used to photograph the transit of Venus), a 12-in. altazimuth by Troughton and Simms, and a large collection of smaller astronomical and physical apparatus, including the largest electro-magnet then in existence.

Simultaneously with the erection of this observatory (1871–1874) Lord Lindsay was organising an expedition to Mauritius for the purpose of observing the transit of Venus in December, 1874, and there are those who remember the astonishment and interest with which astronomers first read in the Monthly Notices of the Royal Astronomical Society for November, 1873, of the scope and extent of these preparations. The very important results of that expedition are published by him in vols. ii. and iii. of the Dun Echt Observatory Publications. They not only include determinations of the longitudes of Alexandria, Suez, Aden, Seychelles, Réunion and Mauritius, but also an experimental determination of the solar parallax by heliometer observations of the minor planet Juno. This latter series of observations was probably the most important result of all the many costly transit of Venus expeditions, for it proved conclusively that the heliometer method of observing minor planets was capable of determining the solar parallax with a precision and certainty that is unattainable by the historic method of the transit of Venus.

On his return to England Lord Lindsay, in addition to his duties as Member of Parliament for Wigan, continued to perfect the equipment of his observatory, and made researches on the spectra of stars, planets and comets—adding at the same time continually new treasures to his splendid astronomical library.

He also instituted, under the able editorship of Dr. Ralph Copeland (who was in charge of his observatory from 1876 to 1889), the valuable series of Dun Echt circulars, by which early intimation of astronomical discoveries was communicated to astronomers.

On the death, in 1880, of his generous and highly cultured father, the twenty-fifth Earl of Crawford, he succeeded to the earldom. The many responsibilities and occupations which then crowded upon him prevented him from taking much farther part in active astronomical research, and although his interest in it never abated, he thereafter left the work of the observatory almost entirely in the hands of Dr. Copeland.

For some years previous to the retirement of Prof. Piazzi Smyth, in 1888, from the post of Astronomer Royal for Scotland, the question of reorganising the Edinburgh Observatory had been under consideration—and it had even been proposed to hand it over to the University. But this was prevented by Lord Crawford's timely action and noble generosity. He offered the whole of the beautiful instrumental equipment of his observatory and its splendid astronomical library to the nation on the sole condition that the Edinburgh Observatory, thus enriched, should be maintained as a royal observatory. This offer was finally accepted and Dr. Copeland was appointed to the vacant offices of Astronomer Royal for Scotland and professor of astronomy in the University of Edinburgh in January, 1889. The great national observatory on Blackford Hill, which owes its existence to the generous action above described, was formally opened in April, 1896, by Lord Balfour of Burleigh in the presence of Lord Crawford.

Our limits of space render it impossible to do justice to the varied activities of Lord Crawford's life; we have therefore confined attention to the side of his career by which his name will chiefly be remembered in the scientific world, although the narrative conveys but little idea of his mental grasp and breadth of view. He had an inborn genius for mechanics and engineering, a love of science in every form, and a passion for travel; and he inherited from his father the love of all things rare and beautiful, together with the instinct of the antiquarian, the bibliophile and the collector. His generous and sympathetic nature endeared him to all who were his fellow-workers, and more than one man has to thank him for scientific opportunity that would otherwise have been denied him.

Lord Crawford's health in his later years was far from good. He once wrote: "It has been my lot to live in close communication with two inseparable hangers-on, the one rheumatism, the other asthma. I found relief by going to sea, provided it was towards the Sunny South. The cold damp of a home winter I have not faced for many years." During these voyages he made important collections of birds, fishes, insects and plants (many of them previously unknown to science), which were presented to the National History Department of the British Museum, or, in the case of live specimens, to the Zoological Society. The story of his last cruise in his yacht, the *Valhalla*, among the little-known islands of the Pacific is told by Mr. M. J. Nicoll in his "Three Voyages of a Naturalist."

During the last four years of his life Lord Crawford was almost a prisoner in his house, Cavendish Square, London, where he occupied a suite of rooms that was maintained at nearly uniform temperature. But his mental activity was unabated, and almost to the last he was closely occupied in preparing a catalogue of a vast number of documents he had gathered together relating to the French Revolution—a collection that includes more than 600 original letters of Napoleon the First.

Lord Crawford joined the Royal Astronomical Society in 1871, and became its president in 1878 and 1879. In recognition of his services to astronomy he was elected a fellow of the Royal Society in 1878. He was a trustee of the British Museum, a Knight of the Thistle, a Knight of Grace of St. John of Jerusalem, a Commander of the Legion of Honour of France and of the Rose of Brazil.

ORIGINS OF HELIUM AND NEON.

At the meeting of the Chemical Society on Thursday last, February 6, two papers were read which have attracted great public attention. One was by Sir William Ramsay, on the presence of helium in an X-ray tube, and the other, on the presence of neon in hydrogen after the passage of the electric discharge through hydrogen at low pressure, was by Prof. Norman Collie and Mr. H. Patterson. An excellent account of the meeting appeared in *The Morning Post* of February 7, and upon it the subjoined revised report is based. Elsewhere in the present issue will be found a communication from Sir J. J. Thomson describing recent experiments of a somewhat similar character made by him, and his interpretation of them.

In the absence of the president of the Chemical Society, Prof. A. Smithells presided at the meeting of the Chemical Society at Burlington House on February 6. Sir William Ramsay, in his paper on the presence of helium in the gas from the interior of an X-ray tube, reminded the fellows that some years ago he and Mr. Cameron had obtained lithium from copper, though people were mildly incredulous. He had also published a statement to the effect that under the influence of radium emanation silicon gave some carbon dioxide, while with thorium a respectable quantity of carbon dioxide was obtained, the inference being that the element tended to break down to carbon, which in the presence of oxygen became carbon dioxide. When the time came for him to have to return the radium that had been lent to him he had looked about for some other substance with which to continue his experiments. Radium gave helium and niton, or radium emanation, and also heat and α rays. Niton was extraordinarily energetic, more so than any other known substance, so that a cubic centimetre of it gave more than three and a half million times the energy of a cubic centimetre of explosive gas. During the decomposition of the emanation α rays were given off and β rays with even greater velocity. The question to determine was whether it was possible to find signs of chemical transformation through the β rays, a difficult one when it was remembered that only 6 per cent. of the energy of emanation appeared in the form of β rays. He had made the attempt, however, with old X-ray bulbs. In the first instance his method had been to break the bulbs, and on analysing the gases contained in the glass by means of the combustion tube, he had found as the only gases helium, neon, and argon. Last November, instead of breaking the bulbs, he had heated them to three hundred degrees, and collected the gases, finding the spectrum of helium and also a small quantity of neon. As a result of these experiments there was no question that the bulbs contained helium. The problem was what was the source of this helium. It might have been derived from the electrons, or from contact with the kathode or anti-kathode, or from the contact of the kathodic rays with the glass. Last summer he had informed the society that on treating water with radium emanation, instead of getting helium, neon was got, the equation suggesting itself that helium (4) plus oxygen (16) equals neon (20). Thus at Bath, when the waters were charged with radium, great quantities of both neon and helium were produced.

Prof. N. J. Collie and Mr. H. Patterson read their paper on the presence of neon in hydrogen after the passage of the electric discharge through hydrogen at low pressures. Prof. Collie directed attention to the fact that he and Mr. Patterson had done the early portion of the work of their joint paper independently and from different points of view, and that it was only in the later stages of the work, when they had learnt that they were getting the same results independently, that they had collaborated. He described his early experiments, which had been undertaken on fluorspar with the hope of decomposing the fluorine by means of the electric discharge. On testing some fluorspar that Sir William Ramsay had received from Iceland last summer he had found that helium was given off. Further investigation showed that the spar gave off carbon monoxide and other gases, and when the problem had been investigated with one of Sir William Ramsay's ingenious pieces of apparatus it had been determined that on treating the spar neon was produced. Further investigation showed that the same result was obtained by using artificial calcium fluoride, and again by using glass wool, and then again by carrying out the discharge in the bare glass tube. What was the origin of the neon? Had air leaked in through the taps of the apparatus? Was it due to impurities in the hydrogen placed in the tube to conduct the current, or to the oxygen used in the later stages to get rid of the hydrogen, or to neon being dissolved in the glass? Prof. Collie described the experiments undertaken to exclude the possibility of there being any such origin for the gas, and also the attempt made with a negative result to see whether the neon could have leaked through the heated glass tube.

At this stage, Mr. Patterson continued the paper, showing the point of view from which he had undertaken the research. He had been interested, he said, in the pure physics of the electron. He described the formulæ on which he had built up a hypothesis, and announced that he had thought it conceivable that by doubling the electrical charge on the hydrogen atom it might be possible to convert this into an α particle, and so into helium. He did not, he said, regard the result of the experiment as proving the hypothesis, but he thought that perhaps his hypothesis provided an explanation.

Prof. Collie then resumed his reading of the paper. He had, he said, criticised Mr. Patterson's method of preparing hydrogen by electrolysis of barium hydrate solution, and to avoid this possibility of error Mr. Patterson had filled his barium hydrate apparatus with pure oxygen, so as to avoid the presence of dissolved air in the barium hydrate solution, but he still obtained neon. Another possibility had then suggested itself. While neon did not enter glass under ordinary conditions, might it not do so under the influence of the X-ray discharge? To make certain on this point the experiment tube was surrounded with another tube containing neon, and about the same result was obtained as before. Several experiments were made with helium in the outer tube; in the inner tube neon was found. Lastly, since sending in his paper the previous week, he had used the outside vessel as a vacuum (a higher than an X-ray vacuum), and still the neon appeared, the quantity thus obtained being comparable with that present in about two cubic centimetres of air. The previous Friday and Saturday he had performed the experiment twice with the experiment tube surrounded by a vacuum. He had then asked himself whether there was anything else he could test. He decided to try whether there was anything in the outer chamber. He let a cubic centimetre of pure oxygen into the outer chamber; having pumped out this oxygen he passed a spark through it, and there was a slight explosion, due to hydrogen. He absorbed the oxygen in the usual way with carbon cooled with liquid air, but there was still some gas left, which he regarded as rather a nuisance. He repeated the process of absorption, but the gas still remained, in relatively large amount. He decided to test it and turned on the coil. The sight he then saw astounded him, for the tube was a blaze of helium, with some neon mixed. He communicated with Mr. Patterson, who repeated the experiment. Mr. Patterson at first found the same. Then he put oxygen into the outer tube, and he found, instead of helium in excess, what appeared to be the neon in excess, the equation being suggested that helium (4) plus oxygen (16) equals neon (20). If the helium had sufficient velocity, when produced in the inner tube, to traverse it, it was quite possible for a new element to be produced. For his own part he was quite satisfied provided neon and helium had been produced from substances in which they were previously not present. There were various possibilities. It might be that the elements of the tube or the electrodes gave neon or helium under the influence of the discharge. This gave them ten or a dozen elements to choose from as the source. Again, there was the chance that the hydrogen was the source or mercury vapour. Or it was possible that they were dealing with a primordial form of matter, the primordial atom which, when produced, had all the energy necessary for forming the universe. By the combination of these "atoms" the atoms of the elements would be formed. Helium, and possibly hydrogen, were present in the hottest stars, and they were present in the experimental tube. Perhaps the electric current was a directed flow of these atoms, and with the phenomena of heat and light the elements came into existence. At any rate one thing seemed certain. The elements could be changed, and they could be changed in a way very different from the way that radium was changed. In its case the process could neither be hastened nor retarded. But the present phenomenon was artificial, and, further, the process was occurring at the other end of the system of the atoms, producing elements of low atomic weight. The old idea of the transmutation of elements had to be altered. We were coming now to know more of subatomic matter, and it had to be realised that—

> The old order changeth, yielding place to new.
> And God fulfils Himself in many ways
> Lest one good custom should corrupt the world.

Prof. Collie then showed two illustrations of the effect of sparking neon, the gas when absolutely pure blazing out into a pillar of perfect flame-red. He added, in conclusion, that he had broken the experiment tube, heated it, and found under the microscope that it was full of bubbles of gas that had been caught in their passage through the tube.

Prof. Smithells, in opening the discussion, said that, without venturing to express any opinion upon the facts or the hypothesis brought forward, it was evident that if the conclusions were substantiated it would be difficult to speak of their importance in language of exaggeration.

Sir William Ramsay expressed his great gratification at other researchers having taken up the investigation. With radium there had been no chance of repetition, but the present experiments on transmutation could be reproduced by anyone with a coil and a battery. He was extremely gratified that the theory of transmutation now no longer rested on his *ipsissima verba*.

Various expressions of opinion by men of science upon the experiments and conclusions described above have been published in the daily papers. Mr. F. Soddy has, we learn from *The Westminster Gazette*, given his views as follows:

The results as regards the apparent formation of helium and neon in vacuum tubes under the influence of the kathode rays have been noticed by previous investigators. A paper published by myself in the Proceedings of the Royal Society, 1908 (p. 94), states that the source of what might be termed the miraculous appearance of helium in a vacuum tube was traced to the power of aluminium electrodes of absorbing these gases during previous use. Baron von Hirsch, of Munich, in 1907 came to this laboratory to investigate a case he had noticed in which he supposed that helium was produced by the kathode ray discharge in a vacuum tube. This we succeeded in completely disproving. These observations show that other workers have investigated the kathode rays in vacuum tubes, and have even thought that helium and other rare gases were produced. It is impossible to say anything about the new experiments of Sir William Ramsay, Prof. Collie, and Mr. Patterson until full publication is available. There is nothing in the paper which leads one to suppose that there is any special new condition to which the production could be ascribed, and, of course, some such condition may account for the results. All that can be said is that other workers have not got helium in experiments which seem to be similar.

NOTES.

MR. R. LYDEKKER writes to say that his letter to *The Times* of February 6 in regard to the supposed cuckoo heard by himself at Harpenden on February 4 is based on an exceedingly clever imitation of the bird's note by a bricklayer's labourer working in a new house in the neighbourhood. Mr. Lydekker has interviewed the man, who states that he produces the sound with his lips alone, and that in the season he is able to attract all the cuckoos in his vicinity to the spot where he utters the call.

MR. W. R. OGILVIE GRANT has been appointed assistant keeper of the department of zoology at the Natural History Museum, South Kensington, in succession to Mr. Edgar Smith, who will retire, by reason of age, on March 31.

THE Friday evening discourse at the Royal Institution on February 28 will be delivered by the Hon. R. J. Strutt on active nitrogen, instead of Mr. C. T. R. Wilson, who will deliver his discourse on the photography of the paths of particles ejected by atoms on March 7.

WE regret to announce the death, on February 8, at sixty years of age, of Prof. M. M. McHardy, late professor of ophthalmology in King's College, London, and the inventor of the registering perimeter which bears his name, for mapping out the field of vision.

THE Helmholtz medal of the Berlin Academy of Sciences has been awarded to Prof. S. Schwendener, of the Berlin University, for his researches in vegetable physiology. Prof. Emil Abderhalden, of the University of Halle, has also received a prize for his researches on egg albumin.

WRITING from Launceston, Tasmania, a correspondent states that the belief that exposure to the rays of the moon has a poisonous effect on fish is very prevalent among the older people in Tasmania. The belief appears to have been taken out by the early settlers, and has become firmly rooted. Communications upon the same subject will be found in NATURE of November 14 (p. 305), December 5 (p. 382), and December 12, 1912 (p. 417).

SIR CECIL H. SMITH, director of the Victoria and Albert Museum, and Dr. E. H. Starling, F.R.S., professor of physiology in the University of London, have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of three persons "of distinguished eminence in science, literature, the arts, or for public service."

DR. W. C. FARABEE, instructor in anthropology at Harvard, has resigned that post in order to accept the leadership of an expedition that the University of Pennsylvania is sending to South America, to remain in the field three years. Its main object will be ethnological research, but representatives of other departments of science will accompany the expedition. Dr. Farabee has previous experience of this region, having conducted a South American expedition for the Harvard Peabody Museum from 1906 to 1909.

AN account of the work of Dr. C. G. P. de Laval, whose death on February 2 was announced in last week's NATURE, is given in *Engineering* for February 7. Dr. de Laval was born on May 9, 1845, and was educated at the Upsala University. His name will be associated with the cream-separator, a machine developed by his ingenuity and application, and also with the well-known steam turbine which bears his name. The latter machine is notable as embodying the first application of Napier's diverging nozzle for expanding steam, and for the principle of mounting the turbine wheels on long flexible shafts; these shafts are run at speeds much higher than the critical speed, and under such conditions remarkable steadiness is secured in the rotor. Dr. de Laval's work in the development of high-speed gearing is well known. He also experimented with steam at exceptionally high pressures, and exhibited turbines in 1897 running with steam at 1500 to 1700 lb. per sq. in. pressure. He was a member of the Swedish House of Representatives.

INTERESTING details of the life and work of the Right Hon. Lord Ilkeston, better known in the world of medical science as Sir Walter Foster, who died on January 31, are given in a long obituary notice in *The British Medical Journal* of February 8. B. Walter Foster was born in 1840, and was therefore in his seventy-third year when he died. Before he had completed his twenty-first year he was appointed professor of practical anatomy and medical tutor at Queen's College, Birmingham. He gave special attention to diseases of the heart, and his best-known contribution to medical literature was a book on the sphygmograph which appeared in 1866. Among his other publications are:—"The Use of Ether and Etherised Cod-liver oil in the Treatment of Phthisis," "Method and Medicine," "The Prince's Illness: its Lessons—a Lecture on the Prevention of Disease," and "The Therapeutics of Diabetes Mellitus." He delivered the address in medicine at the annual meeting of the British Medical Association held in Birmingham in 1890, taking as his subject the public aspects of medicine. He was president of the section of public medicine at the annual meeting held at Nottingham in 1892, and of the section of State medicine at the London meeting in 1910. At a comparatively early period of his career Foster had begun to take an active part in public affairs outside his profession. In Parliament he took a prominent part in the discussion of all questions affecting directly or indirectly the interests of medical practitioners. He became Parliamentary secretary to the Local Government Board in 1892, and held the office until 1895. In 1910 he accepted a peerage, taking the title of Lord Ilkeston at the expressed wish of the constituency he had represented for twenty-three years. He had been a Privy Councillor since 1906. In addition to the distinctions already mentioned, he received the honorary degree of D.C.L. from the University of Durham in 1893, and that of LL.D. from the University of Montreal in 1897.

THE Transactions of the Edinburgh Field Naturalists' Club and Microscopical Society for 1911–12 vol. vi., part 5) contain a portrait and memoir of the late Dr. William Watson, Indian Medical Service, who was president of the society from 1888 to 1891, and died on June 16, 1912, at the age of eighty. Dr. Watson was stationed for many years at Naini Tal, where he saw the disastrous landslip of 1880, acquired special knowledge of Indian botany, and in 1875 was commissioned by Government to furnish a report on the flora of Kumaon.

THE London County Council has issued a handbook to the special series of cases in the Horniman Museum illustrating animal locomotion. The exhibit appears to be of considerable extent, displaying adaptations to swimming, creeping, burrowing, running, leaping, climbing, "parachuting," and flying in various classes of animals, these adaptations being explained in the handbook, which has been compiled by Mr. H. N. Milligan, under the supervision of Dr. Haddon. A plate illustrates the convergence of type presented by various groups of swimming vertebrates, as exemplified by fishes, ichthyosaurs, cetaceans, and sirenians. We believe a special exhibition illustrative of flying is shortly to be opened in the Natural History Museum.

UNDER the title, "Die Mutationen in der Erblichkeitlehre," a lecture delivered by Prof. Hugo de Vries in October, 1912, at the inauguration of the Rice University, Texas, the largest scientific institution in the southern States, for the building and equipment of which the founder, Mr. W. M. Rice, bequeathed ten millions of dollars, has now been published (Berlin: Borntraeger). In this lecture Prof. de Vries reviews the relations between his well-known mutation theory and other theories of evolution—natural selection, orthogenesis, and neo-Lamarckism—replies to various criticisms of the mutation theory, and summarises the chief advances made during recent years in the study of mutation, including the important cytological results obtained by Gates and other investigators. This brochure, presenting the author's latest views, and recounting the progress made during the ten years that have elapsed since the publication of his "Mutationstheorie," will be useful to students of evolutionary biology; numerous references to the recent literature of the subject are included within the comparatively small compass of forty-two pages.

THE Cambridge University Press has published Prof. J. Ward's Henry Sidgwick memorial lecture for 1912, "Heredity and Memory" (1s. 6d. net). The lecture deals in an interesting manner with the hypothesis that heredity is a form of memory. The author differs from some who accept Semon's mnemic hypothesis in believing that it is useless to seek a physical explanation of "engrams," for memory is essentially a psychical process, and heredity, being fundamentally racial experience, is also psychical rather than physical. The general position adopted is thus frankly vitalistic or animistic, and this is justified on the ground that since we know psychical phenomena (mind and purpose) in ourselves, the principle of continuity demands that they must exist also in the lower organisms. It is not justifiable to ascribe the vital phenomena of the lowest organisms to purely physical causes when we have no conception of how such causes could produce the mental phenomena which are characteristic of the highest. A considerable portion of the lecture is devoted to a criticism of Weismann, but a good deal of recent work, some of which might have been used in support of the author's thesis, and some which tells against it, is not mentioned.

MR. R. L. DITMARS, the curator of reptiles of the New York Zoological Society, contributes to a recent number of *Zoologica* (published November, 1912) an interesting paper upon the feeding habits of snakes, based in the main upon observations of specimens in captivity. For the purpose of systematising his subject-matter, the author divides these reptiles according to their method of taking food into two main groups, the non-venomous and the venomous. The non-venomous group contains: (*a*) constricting species, like the Boidæ and some Colubridæ, which coil round their prey and squeeze it to death; (*b*) semi-constrictors, like the Colubrine genera Zamenis and Spilotes, which overcome their prey by holding it in a single coil or by pressing it to the ground, and swallow it alive; (*c*) non-constricting species, like the Colubrine genera Tropidonotus and Heterodon, and the insectivorous Typhlopidæ and Glauconiidæ. The venomous group contains: (*a*) the poisonous Colubridæ, like the sea-snakes (Hydrophis) and the cobras (Naia), which seize their prey and hold it until dead, when swallowing begins; (*b*) the vipers, which stab their prey and immediately release it, awaiting its rapid death by poisoning before attempting to swallow it. This classification is not claimed to be in any sense absolute, but is adopted to indicate the principal methods of overcoming prey practised by snakes. Some very interesting observations are recorded, especially those relating to an example of the king cobra, or Hamadryad (*Naia bungarus*), an example of which showed by its behaviour that it knew the difference between a water viper (*Ancistrodon piscivorus*), a poisonous Crotaline, and a harmless water snake (*Tropidonotus taxispilotis*), although to the human observer the two matched one another closely. The viper it refused to touch, but the innocuous specimen it seized at once. This experiment gains in interest from the fact that the two species offered for food to the cobra are foreign to its native country.

ALTHOUGH the study of plant geography dates back at least as far as Humboldt's time, plant ecology, which is concerned with the detailed and systematic study of plant communities—the groupings of plants found associated together under definite conditions of life—is one of the youngest branches of botany. One of the requirements of a young but progressive subject is a suitable nomenclature, and this Dr. H. Brockmann-Jerosch and Dr. E. Rübel have attempted to supply in their recently published work, "Die Einteilung der Pflanzengesellschaften" (Engelmann, Leipzig, price 2.50 marks). They divide plant communities into four main types—"Lignosa" (woodland and scrub), "Prata" (meadow and marsh), "Deserta," and "Phytoplankton." Each of these is divided into a number of classes of formations, and these again into groups of formations, and these are discussed in some detail, with examples drawn from the rapidly growing literature of phytogeography. Though it is doubtful whether ecologists will accept this scheme in all its details, it will be welcomed as an important contribution to plant ecology from a broad philosophic point of view.

The Meteorological Chart of the North Atlantic and Mediterranean for February (first issue), published by the Meteorological Office, exhibits a cyclonic storm of exceptional intensity over the central portions of the Atlantic in the weekly period commencing with January 9; the storm region occupied practically the whole breadth of the ocean, while anticyclones lay over the United States and northern Europe. At 7h. a.m. on January 10 the ss. *Celtic*, in lat. 49° N., long. 29° W., reported a reading of the barometer so low as 27·44 in., one of the lowest ever recorded over the North Atlantic; on February 5, 1870, the R.M.S. *Tarifa*, in lat 51° 3′ N., long. 23° 39′ W., reported a reading of 27·33 in. It will probably be remembered that at False Point, Orissa (India), the low reading of 27·12 in. was recorded in the cyclone of September 22, 1885; but such extreme values are very rare.

Dr. Rudolf Spitalen, in "Die Eiszeiten und Polschwankungen der Erde" (*Sitzungsb. d. k. Akad. d. Wiss. in Wien*, November, 1912), discusses two distinct problems. He gives a negative answer to the question whether the heaping up of ice over the northern continents in the glacial periods would have been accompanied necessarily by large displacements of the axis of rotation in the earth, and he forms his conclusions after a very considerable amount of careful computation based on very reasonable assumptions. He develops Schiaparelli's discussion of the motion of the earth's axis under the influence of geological changes, and confirms the suggestion that the shifting of the pole may cause displacements of the faulty portions of the earth's crust in a way that would lead to wide wanderings of the pole. The conclusion that the Ice age is to be associated with a considerable shifting of the earth's axis of rotation is necessarily a speculative one, but Dr. Spitalen brings in numerous facts (or perhaps rather theories) from the writings of geologists and geodesists to support his views. It is scarcely possible in the nature of things to prove his case, but he gives a good account of it, which will bear careful study.

Not the least interesting of the many engineering problems presented by the Panama Canal is that of the stability of the sides of the deep cuts. This question is discussed by Dr. Vaughan Cornish in *The Edinburgh Review* for January—"The Panama Canal and the Philosophy of Landslides." The earlier landslides, *e.g.* the big one at Cucuracha, were caused by the top residual clay sliding into the cut upon a lubricated sole; this was dealt with by the removal of practically the whole deposit where slipping appeared probable. Later, in 1910, and again in 1912, when the deepening of the cut was particularly rapid, the movements took the shape of a sudden uplift of the floor, together with bulging of the lower part of the bank. This movement of the earth—incorrectly described as a landslide by Dr. Cornish—is called a "break" by the canal engineers; it is similar in cause and effect to the well-known "creep" of miners. The sudden removal of support produced by the rapid deepening of the cut caused certain weak beds of argillaceous sandstone, and in other cases beds of lignite, to fail beneath the vertical pressure on the sides. The weakness of the rocks was no doubt increased by the access of rain water. The difficulty is serious, as may be seen by the fact that on account of the "breaks" alone more than 16½ million cubic yards of material beyond that in the original estimates have had to be removed. The trouble is being overcome by increasing the batter of the sides and by introducing broad "berms" or benches in them.

The *Verhandlungen* of the German Physical Society for December 30 last include an abstract of a memoir on the expansion with rise of temperature of quartz, various steels, including nickel steels, and a number of bronzes and brasses, by Dr. W. Bein. The complete paper appears in vol. viii. of the *Abhandlungen* of the German Committee of Standards. The method is that of Fizeau, with the improvements introduced by Abbé and by the author. The material tested is in the form of a cylinder one centimetre high, and is placed between horizontal glass plates, kept apart by a quartz ring, as in Reimerde's experiments. The expansion of the quartz is investigated by the interference bands formed by light reflected at the bottom surface of the top, and the top surface of the bottom glass plate. Three lines of the mercury spectrum were used. The following values of the coefficients of t and t^2 respectively were found to hold between 0° and 100° C.:—Quartz, $7{\cdot}15 \times 10^{-6}$ and $0{\cdot}0081 \times 10^{-6}$, steels, 10 to $11{\cdot}5 \times 10^{-6}$ and 0·0045 to $0{\cdot}0075 \times 10^{-6}$; nickel steels, 0·59 to $1{\cdot}48 \times 10^{-6}$ and 0·0018 to $0{\cdot}0045 \times 10^{-6}$; bronzes and brasses, 16·8 to $19{\cdot}1 \times 10^{-6}$ and 0·0036 to $0{\cdot}0052 \times 10^{-6}$. The results for quartz agree with those of Benoit and Scheel. All the metal specimens showed signs of internal stress when first tested.

The Transactions of the Concrete Institute (vol. iv., part iii.) contain an interesting lecture on fireproofing, delivered by Mr. R. L. Humphrey, who is the president of the National Association of Cement Users, Philadelphia, Pa. The conditions in America regarding this subject are notoriously bad, and give the unenviable distinction of having the greatest fire losses in the world, and each succeeding year shows no appreciable decrease. Mr. Humphrey deals, among many other matters, with safety appliances and facilities for the escape of the occupants of a building in the case of fire. Much greater regard is had for life in Britain and on the Continent than in America. Steep iron ladders passing unprotected plain glass windows are common. The Asch building fire provides an example of such a structure, and the consequent loss of life. It is a significant fact that, standing on the pavement of the ill-fated Asch building, one can see within a stone's throw many more buildings that are infinitely worse as regards construction and provisions for safety. Public opinion and continual ridicule of such ill-conceived contrivances is having its effect in that they are rapidly becoming obsolete, and it is hoped that shortly retroactive laws will make such contrivances criminal.

THE tenth of the "Technologic Papers of the Bureau of Standards" issued by the U.S. Department of Commerce and Labour deals with the melting points of fire bricks, and is by Mr. C. W. Kanolt, assistant physicist to the Bureau of Standards. Mr. Kanolt has taken as the melting point the lowest temperature at which a small piece of the brick could be distinctly seen to flow. The experiments were conducted in an Arsem graphite resistance vacuum furnace, the temperatures being determined by means of a Morse optical pyrometer of the Holborn-Kurlbaum type, an improved method of calibrating, which is described. The melting points of fifty-four samples of fire brick, including fire clay, bauxite, silica, magnesia, and chromite brick, have been determined. The following melting points of materials important in the manufacture of fire brick have been obtained by Mr. Kanolt:—Kaolin, 1740° C.; pure alumina, 2010° C.; pure silica, 1750° C.; bauxite, 1820° C.; bauxite clay, 1795° C.; chromite, 2180° C. It is pointed out that the value given for silica is not the true melting point, but represents approximately the temperature at which silica flows distinctly.

FURTHER additions have been made by Messrs. T. C. and E. C. Jack to their series of "People's Books," which, it will be remembered, are sold at 6*d*. net each. Among the new volumes may be mentioned "Zoology, the Study of Animal Life," by Prof. E. W. MacBride, which provides a popular introduction to the science, with chapters on such interesting subjects as the origin of species, the consequences of Darwin's theory, and the bearing of zoology on the questions of human origin and the future destiny of the race. Dr. H. J. Watt's "Psychology" directs attention mainly towards the study of experiences—their analysis, description, classification, and connections. Mr. P. E. B. Jourdain, in "The Nature of Mathematics," endeavours to make the ordinary person understand "speaking broadly, what mathematicians do, why they do it, and what, so far as we know at present, mathematics is." In the volume on "Friedrich Nietzsche," Mr. M. A. Mügge gives a sympathetic account of the life of the philosopher. Another volume takes the form of an atlas by Mr. J Bartholomew, which contains fifty-six plates, and is a marvel of cheapness.

MESSRS. WITHERBY AND CO. are publishing photographic enlargements of six of the principal plates from "The Home-life of a Golden Eagle," by Mr. H. B. Macpherson, which contains some of the most striking pictures of bird-life ever secured. The enlargements measure 9¾ by 11½ in., and that of "The Mother Eagle and her Child," which has been submitted to us, is a most successful example of avian portraiture. The price of each enlargement is 7*s*. 6*d*.

MESSRS. J. AND A. CHURCHILL are the publishers of "Notes on Chemical Research," by Mr. W. P. Dreaper, a notice of which appeared in last week's NATURE. Their name should have been given at the head of the notice.

OUR ASTRONOMICAL COLUMN.

LATITUDE DISTRIBUTION OF ABSORPTION MARKINGS ON Hα SPECTROHELIOGRAMS.—In an interesting note appearing in No. 2, vol. lxxiii., of *The Monthly Notices*, Dr. Royds analyses the latitude distribution of the dark absorption markings found on spectroheliograms taken in Hα light at the Kodaikanal Observatory during the period April, 1911–June, 1912. Seventy-four per cent. of the total areas of absorption markings occurred in the southern hemisphere, and there was a slight preponderance in favour of the western side of the central meridian. The latitude-distribution curve for these markings agrees with that for the limb prominences in showing a striking maximum near latitude 50° S., which is almost absent from the corresponding northern latitude; in the northern hemisphere the maximum is in the zone 25° to 30°. The association of Hα markings with sun-spots is shown by the correspondence of their two latitude curves between the equator and 20° N. and S. It is suggested that maxima in the Hα curve in the higher sun-spot latitudes may denote activity in those regions presignifying the commencement of a new sun-spot cycle.

THE SPECTRUM OF THE CORONA.—The interdependence of physics and astrophysics is emphasised by an article appearing in No. 458 of *The Observatory*, in which Prof. J. W. Nicholson suggests that the spectrum of the corona may be given a physical interpretation, based on the assumption that the "coronium" atom is a simple one, in which the actions of the component electrons may be theoretically determined. The majority of terrestrial atoms are too complicated thus to be analysed, with our present knowledge of mathematics, but among celestial atoms Prof. Nicholson suggests there may be some of sufficiently simple construction to enable the mathematician to determine their structure, and so deduce, from first principles, the nature of the spectrum emitted by them; in "nebulium" and "coronium" he believes such simple atomic structures are to be found.

If, according to theory, the model, simple atom consists of a number of negative electrons revolving about a positive nucleus, it can be deduced that the wave-lengths of the radiations emitted can have a series of values of which the cube roots are in arithmetical progression. Such series are found in the spectrum of the corona, and the theory allows an interpretation of nearly all the lines in this spectrum to be set up.

THE TEMPERATURES OF STARS.—By comparing quantitatively the differences of intensity in various sections of the spectrum, Dr. H. Rosenberg has educed temperatures for seventy stars, and publishes his results in No. 4628 of the *Astronomische Nachrichten*, where he also describes his methods. The temperatures determined range from more than 400,000° C. for γ Pegasi to 2150° for α Tauri, but the former is exceptional, the next lower temperature being 50,000° for γ Cassiopeiæ. The temperature of the sun, the intensity-difference of the spectrum of which forms the basis of the calculations, is, on this scale, 4950°. In the lower temperatures Dr. Rosenberg's results agree fairly well with those of Wilsing and Scheiner, but higher up the scale the values are much greater. The general concordance is shown when the intensity-differences are plotted on a curve having for its abscissæ the various spectral types of Miss Maury's classification, the highest temperatures being exhibited in both cases for the helium stars and those showing bright hydrogen lines in their spectra.

ONE HUNDRED NEW DOUBLE STARS.—Dr. Aitken continues his publication of newly discovered double stars in No. 223 of the Lick Observatory Bulletins. The present list contains the data for 100 objects, all measured with the 36-in. refractor, and brings the total now discovered up to 2500; of these only seventeen have distances greater than 5·0″, while in 1847 the components were separated by less than 2·0″. The original programme included the examination of all stars down to the ninth magnitude, given in the B.D., from the north pole to $-22°$ declination, and 95 per cent. of the area to $-14°$ has now been surveyed; of the remaining area, $-14°$ to $-22°$, only about one-quarter remains to be examined.

CONTRIBUTIONS TO AMERICAN ECONOMIC GEOLOGY.[1]

THE State of Texas consists mainly of plains of Cretaceous and Cainozoic rocks which slope gradually eastward to the Gulf of Mexico. They are interrupted to the north-west of the city of Austin by an outcrop of pre-Cambrian rocks composed of granite, gneiss, and schist, and of some early Palæozoic sediments, including Cambrian and Ordovician. These older rocks of Texas have been described in a bulletin by Mr. Paige, who has proved that they have been faulted up into their present position. These old rocks contain some iron ores, of which the Survey during its work in the region discovered thirty-two occurrences. Only three are sufficiently large to be of economic importance, and their value is still unproved. The ores are masses of magnetite; they occur in the schists and usually along the contact with the granites or in bands of rock crushed between parallel faults. The iron was originally deposited in marine sediments, and has been concentrated in consequence of the intrusion of the granites and diabases and of the faulting. The author, in concluding his discussion, quotes a passage from Van Hise attributing the origin of many ores to the materials of igneous rocks, and he inserts iron in the list given by Van Hise; but the case of iron is so different from the others that this addition is scarcely justified.

The existence of a tar spring associated with some hot springs near Lander, in Fremont County, Wyoming, was sufficient indication of petroleum to justify the search. A report by Mr. E. G. Woodruff describes the geology of the district and the evidence as to its supplies of oil. The neighbourhood consists of a series of rocks ranging from the Carboniferous to Eocene, and including a long series of the Mesozoic. There are two oil-bearing horizons, of which the most prolific is the Embar formation, belonging to the Carboniferous; there is a smaller supply in the Upper Cretaceous. The thirteen existing wells yield a supply of 330 barrels a day. The field is one of those in which the productive positions occur along an anticlinal axis.

The Salt Creek oilfield in Natrona County, also in Wyoming, is described by Mr. C. H. Wegemann. The country consists of Cretaceous rocks, lying between some Eocene beds and one which may be Jurassic. The oil-bearing horizons are the Upper Cretaceous Shannon "Sands," some 8 ft. of sandstone saturated with oil. The oil from a lower bed, the Wall Creek "Sand," rises in intermittent flows like a geyser, and Mr. Wegemann attributes the ascents to the same cause as geyser eruptions. A small quantity of oil also comes from a sandstone at the base of the Cretaceous series, which is regarded as possibly the equivalent of the Dakota Sandstone. This oil is associated with water, which in this case is fresh. Mr. Wegemann briefly discusses the origin of the oil; he regards it as derived from organic matter, and especially fossil fish in the adjacent shales, from which it passed into the sandstones. Mr. Wegemann regards this view as supported by the presence of sulphur in the oil.

The Seward Peninsula, the most western part of the mainland of America, projects into the Bering Sea between Norton Sound and Kotzebue Sound. A reconnaissance geological survey has been in progress for ten years, and has been completed by the work of Messrs. P. S. Smith and H. M. Eakin on two sheets, which include the country extending from the north of Norton Bay eastward to the Lower Yukon Valley. The country is geologically complex. It has a base of Archæan rocks covered by a varied series of Palæozoic sediments. In Middle Mesozoic times the region was occupied by land which was submerged in the Cretaceous, though the evidence as to the exact horizon of the marine Cretaceous beds is still indefinite. Great post-Cretaceous earth movements, accompanied by some igneous intrusions, folded and faulted all the lower rocks; as some of the dykes have been faulted, the movements continued later, but the post-Cretaceous faults had no direct influence on the topography. The country was subsequently dissected by river erosion. The country was never covered by an ice sheet, in spite of its high northern latitude and its proximity to the sea; but the authors discovered traces of small glaciers in some of the valleys. The country has shared in the post-Glacial oscillations which are so conspicuous along the Alaskan coasts. The economic minerals of this district include alluvial gold, silver, lead, and copper, and some Cretaceous coal.

The chief copper mines of Alaska are situated among the Wrangell Mountains at the head of the Copper River. Some of the most promising ore bodies occur in the valley of the Chitistone River, a little to the west of the Canadian frontier. The rocks of this district are all Mesozoic, and include the Upper Triassic Chitistone Limestone and Macarthy Shales. The age of the Kennicott formation is still somewhat doubtful; it has been often referred to the Lower Cretaceous, but in the view of the authors is probably Upper Jurassic. Unlike the Seward Peninsula, the country has a comparatively simple geological sequence, and has been strongly glaciated. It shared in the great Cretaceous uplift, which led to its dissection by stream erosion. The valleys were moulded by ice, which, according to the authors, not only gave them their trough-shaped form, but deepened them by from 1000 to 1500 ft., an estimate based on the height of the hanging valleys. The dissection of the country was aided by two series of faults which intersect at right angles and divide the country into blocks, some of which have been lifted and others lowered. The country was thus disturbed by displacements which, though small, had an important indirect effect. One exceptional geographical feature is described by Moffit and Capps as "rock glaciers." They consist

[1] "Mineral Resources of the Llano-Burnet Region, Texas, with an Account of the Pre-Cambrian Geology." By S. Paige. Bulletin 450, U.S. Geological Survey, Washington, 1911. Pp. 103+v plates+22 figs.

"The Lander and Salt Creek Oil Fields, Wyoming." The Lander Oil Field, Fremont County. By E. G. Woodruff. The Salt Creek Oil Field, Natrona County. By C. H. Wegemann. Bulletin 452, U.S. Geological Survey, Washington, 1911. Pp. 87+xii plates+1 fig.

"A Geologic Reconnaissance in South-eastern Seward Peninsula and the Norton Bay—Nulato Region, Alaska." By P. S. Smith and H. M. Eakin. Bulletin 449, U.S. Geological Survey, Washington, 1911. Pp. 146+xiii plates+15 figs.

"Geology and Mineral Resources of the Nizina District, Alaska." By F. H. Moffit and S. R. Capps. Bulletin 448, U.S. Geological Survey, Washington, 1911. Pp. 111+xii plates+11 figs.

"Contributions to Economic Geology." (Short Papers and Preliminary Reports, 1909.) Part ii., Mineral Fuels. [M. R. Campbell, Geologist in Charge]. Bulletin 431, Washington, 1911. Pp. 254+xii plates+4 figs.

of streams of rock talus with the interstices filled by ice, so that the whole mass can move like a glacier. They therefore resemble the stone rivers of the Falkland Islands, in which the flow was due to interstitial mud.

Bulletin 431 contains a series of short papers and preliminary reports dealing with mineral fuels, including petroleum, natural gas in North Dakota, and the coals and lignites of Alabama and various western States. J. W. G.

RECENT WORK ON INVERTEBRATES.

NO. 3 of vol iv. of "Memoirs of the Department of Agriculture of India" is devoted to the life-history and habits of the big brown Indian cricket (*Brachytrypes achatinus*), the various stages of development being illustrated by a coloured plate. According to the author, Mr. C. C. Ghosh, these insects, which measure nearly two inches in length, and are burrowing and nocturnal in habit, have recently been the cause of considerable injury to various crops, such as jute, rice, and tea.

The parasites of the hymenopterous family Dryinidæ form the subject of Bulletin No. 11 of the Entomological Reports of the Experiment Station of the Hawaiian Sugar-planters' Association. After a review of the classification of the group, Dr. R. C. L. Perkins, the entomologist to the association, describes a number of new species from various parts of the tropics.

To the fourth part of vol. cxxi. of the *Sitzber. K. Akad. Wiss.* (*Math.-Naturwiss. Klasse*) several specialists contribute further accounts of the organisms collected during Dr. Werner's recent zoological expedition to the Egyptian Sudan and northern Uganda, Prof. F. Klapálek describing the Neuroptera, Dr. F. Ris the Libellulæ, the Rev. E. Wasmann the Termites, Dr. Werner the genus Embidaria, and Prof. O. Fuhrmann the cestodes of birds.

Students of distribution, as well as specialists in this particular group, will be interested in Mr. M. Connolly's list of the South African land and freshwater molluscs in the South African Museum, published in vol. xi., part 3, of the Annals of that institution. The total number of species recorded is 596, of which no fewer than forty-one are included in the characteristically Ethiopian genus Achatina.

In part 4 of the same volume Messrs. Goddard and Malan commence a descriptive account of South African leeches (Hirudinea), so far as they are at present known. Although all the families of the group are represented in South Africa, land-leeches have not hitherto been detected, this being due, no doubt, to the unsuitability of the zoologically explored portions of the country to their existence.

The nets of trawlers returning to Hull from the North Sea and the neighbourhood of Iceland have yielded to the search of Mr. John Thompson a rich harvest of the hydroid zoophytes of those waters. These have been studied by Mr. James Ritchies, the results of whose investigations are published in vol. xviii., No. 4, of the Proceedings of the Royal Physical Society of Edinburgh. A considerable increase in our knowledge of certain species has been made, and one form is described as new.

In *The Entomologist's Monthly Magazine* for November Mr. Claude Morley discusses a certain mysterious sibilant humming in the air said to be not uncommonly heard during the summer in this country. That the sound is due to insects there can be no reasonable doubt, and Mr. Morley considers himself justified in attributing it to two species of Chironomids, *Chironomus dorsalis* and *Tanypus varius*, both of which normally fly at a high elevation. The ground for this identification is that during a bout of the humming gusts of wind arose which drove specimens of these insects within reach. That Chironomidæ are capable of producing sounds has been previously recorded in America.

To the *Sitzungsberichte der Kgl. Böhm. Ges. Wiss.* for 1911 Dr. E. Schera communicates the first two parts of a study of Turbellarians, mainly based on specimens collected in various parts of Bohemia. Such a critical study, it is claimed, was urgently needed, since many of the genera and species have been named on insufficient materials, and synonyms are consequently rife, and even now certain forms cannot, for the same cause, be properly described. In the first part of his memoir the author describes certain new genera and species, while in the second he monographs the group Olisthanellini.

To Records of the Indian Museum, vol. vii., part 4, Messrs. F. H. Gravely and S. P. Agharkar communicate notes on the habits of the Indian fresh-water jellyfish (*Limnocnida indica*), the discovery of which was recorded in NATURE, vol. lxxxvii., p. 144, 1911. The species occurs in western Indian in the Yenna and Koyna, tributaries of the Krishna, and it is believed also in the Krishna itself near Dhom. It has been observed in April and May, and is well known to the natives, by whom it is called *chakraphul* (wheel-flower), deep pools forming its favourite haunts. From the lack of any evidence of the occurrence of special resting eggs, it is inferred that there must be a fixed hydroid generation. R. L.

MIGRATIONS BETWEEN AUSTRALIA AND AMERICA.

A PAPER by Mr. Hans Hallier on former landbridges, and plant and human migrations between Australia and America, appears in *Mededeelingen van's Rijks Herbarium*, Leyden, for 1912, No. 13. At the outset the author refers to earlier conclusions, based on botanical evidence, that Indonesia, Australia, and Polynesia at one time formed a great Australian peninsula, most of which subsequently sank, either wholly or in part, leaving the mountains of Tasmania, New Zealand, New Caledonia, the Louisiades, New Guinea, the Moluccas, Celebes, the Philippines, Formosa, &c., to serve as centres of plant-dispersal between China and Polynesia, these being separated by deep sea from the mountains of eastern Australia. In earlier times the peninsula was connected by land with America, the northern boundary of this bridge extending from southern Japan through the Sandwich and Revilla-Gigedo Islands to Lower California, while the southern limit seems to have passed by way of the Society and Paumotu Islands from Tasmania through the Auckland, Campbell, Antipodes, and Chatham groups, and thence through Easter Island, Sala-y-Gomez, and Juan Fernandez to the south of Chile. To summarise the evidence of community of origin of the flora of this area, and of the relationships of language-roots, is here impossible, but reference may be made to certain American designs, considered by Wiener to represent lamas, but, according to the author, intended for kangaroos. After stating that, from linguistic evidence, southern Asia should be regarded as the dispersal-centre for the life of Indonesia and Polynesia, and referring to the community of type between ancient Egyptian, American, and south Asiatic art, the author expresses the opinion that Egyptian and American culture travelled from a south Asiatic source by two routes, one to Africa, and the other by way of Indonesia and Polynesia to America.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The Board of Anthropological Studies has recommended to the Senate the establishment of a tripos examination in anthropology, which shall rank as equivalent to the second part of any of the existing triposes and be open to candidates on the same conditions. The board feels strongly that familiarity with the material of modern anthropology and with the scientific methods which it employs must prove of great value to those students who have received a training in theology, law, history, linguistics, economics, and kindred subjects, and more especially to those who intend to undertake research. From all candidates for such a tripos the board considers that a general knowledge of anthropology as well as a more detailed knowledge of a selected geographical area should be required. In order to meet the varying interests of candidates, the board is of opinion that in each year two areas should be prescribed by the board, and that candidates should be allowed the option of making a detailed study of the anthropology of one of these areas.

Mr. Rudolf Albert Peters, of Gonville and Caius College, has been elected to the Benn W. Levy studentship. The appointment is for one year.

The Vice-Chancellor has appointed the Right Hon. the Earl Curzon of Kedleston, Chancellor of the University of Oxford, to the office of reader on Sir Robert Rede's foundation for the present year. The lecture will be delivered in the Easter term, and its subject will be "Modern Parliamentary Eloquence."

Sir Dorabji J. Tata has announced his intention of giving to the Forestry School 100*l*. a year for five years, from March, 1913, for instruction in forestry which will be of benefit to India.

At a special Convocation of the University of Calcutta, held on January 25, the honorary degree of doctor of science was conferred upon Dr. A. R. Forsyth, F.R.S.

The governors of the Wye Agricultural College have approved of the purchase of twenty-two acres of land situated at Malling for a fruit research station, and have also decided to institute during the summer a course of specialised instruction in entomology and mycology for county instructors of horticulture, towards the cost of which the Board of Agriculture will be prepared to make a grant.

We learn from *Science* that the will of Alfred Samson, who died recently at Brussels, provides for an endowment of 100,000*l*. for the Prussian Academy of Sciences, and 20,000*l*. for the Bavarian Academy of Sciences, at Berlin and Munich. The endowments are stated to be for investigations which afford a prospect of raising the morality and well-being of the individual and of social life, including the history and prehistory of ethics, and anthropological, ethnological, geographical, geological, and meteorological influences as they have affected the mode of life, character, and morals of man.

On Tuesday, February 11, Mr. D. M. S. Watson began a course of twenty lectures on the morphogenesis of the mammalia from a palæontological point of view, to be delivered at University College, London, on Tuesdays and Thursdays, at 5 p.m. Dr. F. W. Edridge-Green will deliver a course of four lectures at the college on the physiology of vision and colour vision, on Wednesdays, at 5 p.m., beginning on February 19. The lectures will be illustrated by numerous experiments and demonstrations. Application for admission to both courses of lectures should be made to the secretary of the college.

The Mansion House Committee of Associations for Boys met at the Mansion House on February 5 to confer with representatives of various Government Departments on the advisability of forming an inter-departmental committee to deal with questions concerning the training and care of boyhood. The following resolution was passed:—"This conference would welcome the formation of an inter-departmental committee of the State Departments concerned with the welfare of boys, which should consider questions regarding moral, physical, and industrial education, and also work in closer cooperation with the voluntary associations in the United Kingdom, now numbering 280,000 boys, while leaving them free to pursue the ends for which they were established."

A Eugenics Education Conference is to be held at the University of London, South Kensington, on March 1. Major L. Darwin, president of the Eugenics Education Society, will deliver his presidential address, taking for his subject, "The Eugenic Ideal." During the meeting Canon Lyttelton, headmaster of Eton College, will speak on racial responsibility as a factor in the formation of character, and Prof. J. Arthur Thomson, professor of natural history in Aberdeen University, will open a discussion on the method of introducing the eugenic ideal into schools. At the close of the meeting, should it appear to be in accordance with the general feeling of the meeting, Major Darwin will propose, "That the Minister of Education be asked to receive a deputation requesting an inquiry as to the advisability of encouraging the presentation of the idea of racial responsibility to students in training, and children at school."

Mr. G. A. Wills and his brother, Mr. H. W. Wills, have offered to the council of Bristol University the sum of 150,000*l*. for the extension of the University buildings. Their proposal is to erect a building that shall not only include a large hall, libraries, council chamber, offices for the registrar and staff, lecture-rooms, and a main entrance, but also present to the chief thoroughfare an architectural elevation at once worthy of the University and an ornament to the city. The donors also suggest a small committee to act with them in carrying out the scheme, and lay down the following conditions:—Not less than 20,000*l*. is to be set aside for an endowment for the expenses of lighting and heating and the other establishment charges it will entail. The work is to begin not later than the spring of next year, and to be completed not later than 1917. The whole sum is to be paid when the building contract is signed. In addition to this generous offer, the council has received a letter from Mr. W. Melville Wills, of the same family, offering the sum of 20,000*l*. in memory of his father, Mr. H. Overton Wills, in augmentation of the general endowment fund of the University. The council has accepted the offers gratefully.

Prof. E. A. Schäfer was entertained at dinner by the Edinburgh University Club in Sheffield on February 8. During the course of a speech, we learn from *The Times*, he complained of the lack of State help for universities in this country. Great Britain does not recognise its responsibilities in this respect. Prof. Schäfer said the State makes miserable grants and attaches conditions sometimes which cannot be fulfilled. We ought to take a lesson from other nations. Some towns support their universities, but the University of Edinburgh has no support from its city, although the University is the mainstay of Edinburgh's prosperity. Speaking of the training of doctors, he remarked that the tenure given to the medical curriculum is all too short to obtain the necessary knowledge of the sciences upon which medicine and surgery are based. It is absurd that anybody should attempt to learn medicine, surgery, pathology, and pharmacology unless he has already a fair knowledge of anatomy and physiology. We shall have to get rid of some of the subjects of the curriculum to the extent that is necessary for an understanding of physiology. Biology, physics, and chemistry can be taught just as well, Prof. Schäfer thinks, at school as at the university.

At the end of last month the president and fellows of Harvard College voted to establish the Harvard University Press, for the publication of works of a high scholarly character. For some years the University Publication Office, besides printing the catalogues, department pamphlets, and other official documents, has found it possible, in spite of its limited resources, to issue from time to time a few special works, until it now publishes seven periodicals and more than eighty books, ranging from treatises on Indic philology to practical directions for American lumbermen. To organise and extend this activity, so as to make the University properly effective as a publishing centre for scholarly books, is the object of the new foundation. The agent of the Press in England will be Mr. Henry Frowde. The function of a university press should be to publish works of prime importance and distinctive merit which can rarely be profitable undertakings, but are nevertheless of high value to students in various departments of intellectual activity. This appears to be the aim of the Harvard syndics, as it is of like boards of other universities in the United States. When a university press concerns itself largely with the issue of textbooks for schools and college, considerations of commercial profit tend to predominate over those relating to the advancement of learning, with which purpose alone a university should be associated.

A letter to *The Times* of February 10, signed by Mr. A. C. Benson and three other distinguished Cambridge men, says it is proposed to present to the council of the Senate of the University of Cambridge a memorial suggesting that a syndicate should be appointed to review the whole question of examinations conducted by the University, for which preparation normally takes place at school. It is pointed out that Greek cannot much longer be retained as a compulsory subject in the previous examination. But merely to abolish one compulsory subject, without at the same time carefully devising an examination suitable to the curricula of efficient English secondary schools, would, in the opinion of the memorialists, be harmful to the best interests of English education. An effort should be made, they think, to coordinate the various preliminary examinations which are conducted by university bodies. They desire also to simplify the examinations conducted by Cambridge so that they should practically be reduced to two in number, suited respectively to candidates of sixteen and eighteen years of age. The whole subject will demand the most careful consideration from the syndicate, which is asked for, and it will be desirable that its members should have an intimate knowledge of the relations of secondary and university education. The hope is expressed that experienced teachers will be placed on the syndicate. The text of the memorial is given in *The Times* of the date mentioned. Signatures of those who desire to see consideration given to the feasibility of the changes should be sent to Mr. A. C. Benson, The Old Lodge, Magdalene College, or to the Rev. Dr. Barnes, Trinity College, Cambridge, from whom copies of the memorial can be obtained.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 6.—Sir Archibald Geikie, K.C.B., president, in the chair.—S. R. **Wells** and Leonard **Hill**: The influence of the resilience of the arterial wall on blood pressure and on the pulse curve. The form of the pulse curve and the systolic and diastolic pressure (measured by the sphygmomanometer in the case of man) are modified very greatly by the conduction of the pulse along any particular artery. The conduction varies with the resilience of the arterial wall. An artery which is contracted, and therefore more rigid, conducts the systolic crest almost with undiminished amplitude from the heart to the peripheral vessels, and there is in such an artery a wide difference between the systolic and diastolic pressure. In a relaxed, resilient artery, on the other hand, the systolic wave expands the wall of the artery, and part of its energy is stored up as potential energy in the wall. As this comes into play during diastole and the systolic wave reaches the peripheral vessels in diminished form, the height of the diastolic wave is approximated to that of the systolic. The arteries are controlled so as to bring about one or other of these conditions at the periphery—a hammer-like pulse with big difference between systole and diastole, or a pulse with small difference and a more uniform mean pressure. The evidence for these conclusions has been drawn both from the investigation of thin-walled rubber tubes (specially made) and of arteries.—A. A. **Gray**: The occurrence of a ganglion in the human temporal bone, not hitherto described. The ganglion referred to in the title was found in the human temporal bone, below and in front of the stapedius muscle. In the specimen in which it was discovered the ganglion was comparatively large, but it is probable that considerable variations in this resp ct occur in individuals. So far as present investigations show the ganglion is associated with two nerves—the facial nerve and Arnold's nerve—but it is possible that fibres from other nerves may enter the ganglion.—J. A. **Gunn** and F. B. **Chavasse**: The action of adrenin on veins. (1) The action of adrenin upon ring preparations of veins remote from the heart is to diminish their calibre, as in the case of arteries. They, therefore, probably contain veno-constrictor nerve fibres from the thoracico-lumbar sympathetic system. (2) The action of adrenin on quiescent rings from the superior vena cava near the heart is to cause them to beat rhythmically and powerfully. (3) (*a*) The accelerator-augmentor nerve supply of the heart, and (*b*) the rhythmically contractile tissue, extend up the superior vena cava for at least 6 to 8 mm. from the veno-auricular junction in the heart of the sheep. (4) The induction by adrenin of rhythmic contraction in the quiescent superior vena cava seems, on the whole, in accordance with the myogenic theory of mammalian heart rhythmicity. Capt. H. S. **Ranken**: A preliminary report on the treatment of human trypanosomiasis, and yaws, with metallic antimony. The object of this preliminary report is to demonstrate that intravenous injection of metallic antimony in a fine state of division is a therapeutic measure applicable on a large scale to the treatment of human trypanosomiasis. A considerable number of cases have been treated by this method, and in a further series combined treatment was employed, salvarsan or atoxyl being given in addition to the antimony. As a routine dose, one grain of antimony was given in four to six ounces of physiological salt solution. Summaries of results of the various series are given. In the great majority of cases treatment brought about considerable improvement, as evidenced by disappearance of trypanosomes from the blood and lymphatic glands, improvement in nutrition, mental state, &c.—Major W. B. **Fry** and Capt. H. S. **Ranken**: Further researches on the extrusion of granules by trypanosomes and on their further development. With a note by H. G. **Plimmer** on a new method of blood fixation. Following a short description of methods used in these investigations, the paper deals with the subject of granules in general in trypanosomes. Two classes of granules are referred to:—(*a*) Those representing probably stored food material, and (*b*) those of nuclear origin and character, with which latter only the paper is concerned. Descriptions of the mechanism of extrusion are detailed as observed to take place in human and animal varieties, and the influence of drugs and other effects are discussed in this connection. A description of the free granule and its after-development and fate is given. A section on fixed and stained specimens follows, the earlier sections of the paper dealing in general with observations made of the parasite in the living state.

Geological Society, January 22.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—H. H. **Thomas**: The fossil flora of the Cleveland district of Yorkshire. I., The flora of the Marske Quarry. With notes on the stratigraphy, by the Rev. G. J. Lane. Several plants collected in the Cleveland district of Yorkshire are described. Other specimens dealt with were obtained from the Marske Quarry. The Marske flora, which includes several types not hitherto recorded from the Jurassic plant-beds of Yorkshire, is believed to be of Middle Jurassic age. A note is appended on the stratigraphy of the Marske Quarry, situated on the northern face of the Upleatham outlier, about a mile distant from Marske-by-the-Sea. The Marske beds are assigned to the Lower Estuarine Series.—C. **Thompson**: The derived Cephalopoda of the Holderness Drift. It is claimed that about 180 species of ammonites are already in hand from the Glacial Drift. A large number are new to Yorkshire lists hitherto published, and the matrix of many of them cannot be matched now by our land exposures. The whole of the Lower Lias is represented by all its genera, and the rocky matrices are characteristic, and it is urged that the ice plucked them from outcrops in the bed of a former North Sea; also these outcrops show the continuity of the North Yorkshire Basin with that of north-western Germany. The Middle and the Upper Lias afford much material, but the types are closer to those of North Yorkshire. The Oolites are scantily represented, although the Lower Cretaceous is abundantly represented both by ammonites and by belemnites. The Chalk belemnites belong to a zone higher than any known in Yorkshire; therefore, they probably came from the seabed.

CAMBRIDGE.

Philosophical Society, January 27.—Mr. J. E. Purvis in the chair.—Sir J. J. **Thomson**: Further applications of positive rays to the study of chemical problems. The author described the application of positive rays to the detection of the rare gases in the atmosphere. Sir James Dewar supplied two samples of gases obtained from the residues of liquid air. One sample which had been treated so as to contain the heavier gases was found on analysis to contain xenon, krypton, argon. There were no lines on the photograph unaccounted for, hence there are no unknown heavy gases in the atmosphere in quantities comparable with the known gases. The other sample, which had been heated so as to contain the lighter gases, was found to contain helium and neon, and, in addition, a new gas with the atomic weight 22. The relative brightness of the lines for this gas and for neon shows that the amount of the new gas is much smaller than that of neon. The second part of the paper contained an investigation of a new gas of atomic weight 3 which this method of analysis had shown to be present in the tube under certain conditions. The gas had occurred sporadically in the tube from the time of the earliest experiments, but its appearance could not be controlled. After a long investigation into the source of this gas, it was found that it always occurred in the gases given out by metals when bombarded by kathode rays; a trace of helium was also usually found on the first bombardment. The metals used were iron, nickel, zinc, copper, lead, and platinum; the gas was also given off by calcium carbide. Various experiments were described which illustrated the stability of the gas (see also p. 645).—R. D. **Kleeman**: The atomic constants and the properties of substances. Formulæ are developed by means of which the critical quantities of a substance can be calculated in terms of atomic constants, given the nature of a molecule. These constants are the atomic volumes and the atomic attraction constants obtained in a previous paper. Knowing the critical constants, the pressure of the saturated vapour, its density, the internal heat of evaporation, &c., can be obtained from the law of corresponding states. Applications in chemistry are given.—H. C. **Pocklington**: Some diophantine impossibilities.—A. E. **Oxley**: The variation of magnetic susceptibility with temperature. Part ii., Aqueous solutions. Starting from Curie's laws and taking into consideration the various complexes which exist in solution, and the way in which these complexes dissociate with rise of temperature, the formula $\chi = A/\theta + B + C.\theta$ is deduced; where χ is the susceptibility θ the absolute temperature, and A, B, and C are functions of the concentration. This formula represents the results of observation accurately.—R. D. **Kleeman**: The properties of a substance connected with its surface tension. Deductions are made from fundamental formulæ developed in previous papers in connection with surface tension. It is shown that the various relations that have been found connecting surface tension with other quantities have as foundation certain fundamental relations. A new method of obtaining the absolute mass of the hydrogen atom was developed. It gave for the quantity in question $1{\cdot}56 \times 10^{-24}$ grams.

MANCHESTER.

Literary and Philosophical Society, January 21.—Prof. F. E. Weiss, president, in the chair.—Prof H. B. **Dixon** and H. M. **Lowe**: Experiments on Abel's theory that incombustible dusts act catalytically on igniting weak mixtures of methane and air. The use of fine incombustible dusts as a means of preventing explosions of coal dust in mines has brought into prominence the conclusions arrived at by the late Sir Frederick Abel, viz., that the presence of such incombustible dusts in a mine may bring about the explosion of small percentages of fire-damp in air which would not otherwise be inflammable. While Abel's experiments have been repeated on a similar scale at the Home Office Experimental Station at Eskmeals during the past year with negative results, the explanation advanced by Abel has also been examined experimentally in the Manchester University chemical laboratories. Abel's explanation is that the finely divided dust, heated up by the lamp flame, allows chemical action to take place on its surface—just as platinum brings about the combination of hydrogen and oxygen—and that the oxidation of the fire-damp proceeds with increased rapidity as the dust becomes more highly heated. The dust particles are thus raised to incandescence and fire the gas mixture around them. This involves the assumption that an amount of combustible gas, which is insufficient to propagate flame in the mixture, can by suffering partial combustion bring the remainder into an explosive state. The heating up of a gas mixture by an external source of heat increases its explosive power; but this is not found to be true if the heat is derived from the burning of the gas itself. The authors have heated up mixtures of coal gas and air and mixtures of methane and air by means of a long platinum spiral through which an electric current was passed. After chemical combustion is started the mixtures become *less* and not more explosive, although only a portion of the heat is derived from combustion of the gas itself. Even if the incombustible dusts acted like platinum it would be difficult to explain Abel's results as being due to a catalytic action. Experiments carried out at Eskmeals show that the presence of fine incombustible dusts does not increase, but retards, the rate of explosion of gaseous mixtures.

EDINBURGH.

Royal Society, January 20.—Dr. B. N. Peach, F.R.S., vice-president, in the chair.—J. M'Lean **Thompson**: Studies in floral zygomorphy. I., The initiation of staminal zygomorphy. A study of the very young buds and expanded flowers of *Gregia Sutherlandii* showed that in all the parts of the flower zygomorphy was initiated, but it was not maintained. In the case of the stamens the filaments did not attain the maximum length simultaneously; but sooner or later they all attained the maximum length, and when this stage was reached the anthers dehisced. It was shown that the lengthening of the filaments was due to the elongation of the cells, the number of which remained the same from an early development stage up to the perfected condition.—Dr. C. G. **Knott**: Change of electrical resistance of nickel subjected to cross-magnetic fields. The nickel was in the form of tape-like strips, which could be rolled into compact coils and set in the air-gap of an electromagnet. Moderate fields were in these circumstances sufficient to produce easily measurable changes of resistance in transverse fields. The nickel coils were made the cores of transformer-wound anchor-ring electromagnets, and by passing a current through the enveloping wire longitudinal fields of sufficient strength were obtained. The most curious facts established were these:—(1) Although, as is well known, longitudinal magnetisation is accompanied by increase of resistance, yet when the nickel is maintained in a steady state of transverse magnetisation the effect of the same longitudinal field superposed upon the transversely magnetised state is in most cases to diminish the resistance. (2) When a transverse field is superposed upon a steadily maintained longitudinal field the decrease of resistance is numerically greater than when the transverse field acts alone, and this in spite of the fact that a longitudinal field acting alone produces an increase of resistance.

PARIS.

Academy of Sciences, February 3.—M. F. Guyon in the chair.—L. **Lecornu**: The security of aeroplanes. For the study of the important question of safety in aëroplanes a society has been formed called the "Union pour la sécurité en aéroplane." From its funds it proposes to award a prize of 400,000 francs in connection with this question. Neither plans, memoirs, nor reduced models will be considered; only full-size working machines will be admitted to the competition.—A. **Müntz**: Luminosity and plant assimilation. Although in experiments carried out in confined atmospheres the amount of assimilation has been found to depend largely on the intensity of the light to which the plant has been submitted, data are given to show that this is not the case with plants growing in the open air. The probable reason for this is that the carbon dioxide is present in a much higher proportion in the confined air, and even a dull diffused light is sufficient to take full advantage of the small proportion of carbon dioxide present in outside air.—A. **Blondel**: The origin of wireless telegraphy by means of musical sparks. A claim for priority; the author's first use of this method dates back to 1898.—G. **Tzitzéica**: Derived networks.—D. **Pompéiu**: An application of the functional calculus to the theory of functions.—Joseph **Pérès**: The determination of all the permutable functions of the first species with a given function.—A. **Bilimovitch**: The equations of motion of non-holonomial conservative systems.—Paul **Jégou**: The phenomena occurring in the electrolytic detector not provided with an auxiliary electromotive force and theoretical considerations on the working of electrolytic detectors.—C. **Gutton**: The duration of the establishment of electrical double refraction. A description of experiments showing that in a field of force of variable intensity the variations of the electrical double refraction of bromonaphthalene and carbon bisulphide do not follow exactly those of the electric force. The results of these experiments are in accord with the theory of the orientation of the molecules developed by Langevin.—H. **Buisson** and Ch. **Fabry**: A microphotometer designed to measure the opacity of photographic plates.—Jean **Meunier**: The spectra of nebulæ. In addition to hydrogen, the author identifies some of the lines with iron and titanium. The possibility of the existence of iron and titanium in absolutely gaseous flames is discussed.—G. **Charpy** and S. **Bonnerot**: The reactions which accompany the osmosis of hydrogen through iron. The passage of hydrogen through iron at 600° C. is shown to result in the elimination of some of the impurities of the metal, phosphorus, sulphur, and carbon being removed. The conclusion is drawn from these results that iron and steel, manipulated without special precautions in contact with air, are generally saturated with hydrogen.—J. **Bougault** and M. **Mouchel-la-Fosse**: The action of the alkaline sulphites on the ethylenic acids. Certain unsaturated acids instantaneously fix a molecule of sodium bisulphite, and this reaction can be applied to the separation of unsaturated and saturated acids. 1 cg. or 2 cg. of benzoic acid has been easily separated in this way from 1 gram of cinnamic acid.—Paul **Guérin**: The seminal tegument in the Thymeleaceæ.—A. **Pinard** and A. **Magnan**: The fragility of the male sex. In 52,689 accouchements there were 7056 deaths before or after birth. An analysis of the data, collected over twenty years, shows that before birth the mortality was the same for both sexes; the increased male mortality during and immediately after birth is attributed by the authors to the mechanical effects of the greater weight and size of the male infants and not to any inherent delicacy in the male.—J. G. de **Man**: A new observation of *Menippe convexa* inhabiting the empty shells of Balanus.—M. **Javillier**: The substitution of glucinium for magnesium or zinc in the culture of *Sterigmatocystis nigra*. Experiments are quoted showing that glucinium cannot replace magnesium or zinc as a catalytic agent in the growth of this mould. Charles **Lepierre**: The replacement of zinc by glucinium in the culture of *Aspergillus niger*. The results obtained are opposed to those given in the previous paper. Louis **Duparc**: The origin of the platinum in the alluvial deposits of certain lateral affluents of the Koswa, North Urals.—De Montessus de **Ballore**: Destructive earthquakes and the seasons.

New South Wales.

Linnean Society, November 27, 1912.—Mr. W. W. Froggatt, president, in the chair.—Dr. H. L. **Kesteven**: A new endoparasitic Copepod: morphology and development.—D. **McAlpine**: The fibro-vascular system of the quince fruit, compared with that of the apple.—Dr. R. Greig **Smith**: Contributions to our knowledge of soil-fertility. No. 6, the inactivity of soil-protozoa. When suspensions of soil-protozoa containing *Colpoda cucullus* were added to soils previously treated with chloroform, &c., it was found that the numbers of bacteria were not decreased, and further examination showed that the cysts of Colpoda were not destroyed by the volatile disinfectant. Suspensions of amœbæ did not induce a diminution of the bacterial increase, and the great augmentation of the bacteria that occurs during the first few days was shown to occur also when pure cultures of rapidly growing bacteria, such as *Bact. putidum*, which accompany the amœbæ, were added. Experiments with unfiltered and cotton-wool-filtered suspensions of soil did not show any indication of the activity of the soil-protozoa, from which it is to be inferred that the toxins and nutrients of the soil are alone concerned in the changes that occur in the numbers of bacteria in soils which have been heated or treated with volatile disinfectants.—A. A. **Hamilton**: A new species of Eriochloa (Gramineæ) from the Hawkesbury River.—R. J. **Tillyard**: Description and life-history of a new species of Nannophlebia (Neuroptera: Odonata). The larva and imago were discovered on the Bellinger River, N.S.W., in November last. The discovery is important, because no other larva belonging to Ris's group i. of the Libellulinæ has so far been found. As this group contains all the supposedly archaic remnants of the subfamily, it was expected that the larva would throw some light on the phylogeny of the groups of the Libellulinæ in general.—L. A. **Cotton** and A. B. **Walkom**: Note on the relation of the Devonian and Carboniferous formations west of Tamworth, N.S.W.—G. A. **Waterhouse**: Notes on Australian Lycænidæ. Part v.—Dr. S. J. **Johnston**: Some trematode parasites of marsupials, and of a monotreme. Two species of Harmostomum, parasites from the marsupial "cat" *Dasyurus viverrinus*, and the bandicoot, *Perameles obesula*, respectively, are described as new.

Calcutta.

Asiatic Society of Bengal, January 8.—Rasik Lāl **Datta** and Haridās **Sen**: A new series of double sulphates of barium and hetero-cyclic ammonium bases. Part i.—J. Coggin **Brown**: The A-ch'ang (Maingtha) tribe of Hohsa-Lahsa, Yunnan. The A-ch'angs are one of the smaller groups of the lesser-known tribes of the Burma-China frontier. Their headquarters are in the twin States of Ho-hsa and 'La-hsa in the western part of the province of Yunnan, China. The exact position of the A-ch'angs in the generally accepted scheme of racial classification is a matter of controversy amongst Indo-Chinese anthropologists, and the whole question is reviewed in this paper in the light of further evidence obtained by the author during a short residence in their country. It is concluded that the grouping of the A-ch'ang with the Maru, Zi, Lashi, and Hpon tribes is correct.—E. **Brunetti**: House-flies and blood-sucking Diptera taken in Galilee in October, 1912, by Dr. N. Annandale.—Dr. N. **Annandale**: Papers on the biology of the Lake of Tiberias. No. II., Notes on the fish, batrachia, and reptiles. The fish fall into four geographical groups as follows:—(1) Palestinian species; (2) African species; (3) Asiatic species; and (4) Mediterranean species. The first group is the largest and the last the smallest; the African group forms an important element in the fauna. The Palestinian race (*rufus*, Heckel) of *Discognathus lamta* (H.B.) differs in minor characters from the typical race from Bihar. The batrachian and reptilian fauna of the lake is a poor one, including only five species.

BOOKS RECEIVED.

Notes on Sampling and Testing. The Handbook of the Manchester Chamber of Commerce Testing House and Laboratory. Second edition. Revised and enlarged. Pp. 96+4 plates. (Manchester: Marsden and Co., Ltd.) Paper, 1*s*.; cloth, 1*s*. 6*d*.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1912. (London: H.M.S.O.; Wyman and Sons, Ltd.) 4*s*. 6*d*.

Aus Natur und Geisteswelt: Experimentelle Abstammungs- und Vererbungslehre. By E. Lehmann. Pp. viii+104. Die Funkentelegraphie. By H. Thurn. Zweite Auflage. Pp. vi+128. Grundlagen der Elektrotechnik. By A. Rotth. Pp. 126. Masze und Messen. By Dr. W. Block. Pp. 111. Das astronomische Weltbild im Wandel der Zeit. By Prof. S. Oppenheim. Zweite Auflage. Pp. 134. (Leipzig: B. G. Teubner.) Each 1.25 marks.

Department of Agriculture and Technical Instruction for Ireland. Fisheries Branch. Scientific Investigations, 1911. No. 1, Report of a Survey of Trawling grounds on the Coasts of Counties Down, Louth, Meath, and Dublin. Part iii., Invertebrate Fauna. By A. L. Massy. Pp. 225+ii plates. (Dublin: H.M.S.O.; E. Ponsonby, Ltd.; London: Wyman and Sons, Ltd.) 2*s*.

Transactions of the Royal Society of South Africa. Vol. iii., part 1, 1913. Pp. 185+plates. (Cape Town: Royal Society of South Africa.) 17*s*.

Transactions of the Linnean Society of London. Second Series. Botany. Vol. viii., part i.: A Contribution to a Knowledge of the Mutating Oenotheras. By Dr. R. R. Gates. Pp. 67+6 plates. (London: Linnean Society; Longmans and Co.)

A First Book of Rural Science. By J. J. Green. Pp. viii+146. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Board of Agriculture and Fisheries. Agricultural Statistics, 1911. Vol. xlvi., part 5: Colonial and Foreign Statistics, with Index to vol. xlvi. Pp. 379–521. (London: H.M.S.O.; Wyman and Sons, Ltd.) 7½*d*.

Experimental Mechanics and Physics. By A. H. E. Norris. Pp. viii+176. (London: Mills and Boon, Ltd.) 1*s*. 6*d*.

Tamango, José Maria le Brigand. By Prosper Mérimée. Edited by R. R. N. Baron. Pp. vi+92. (London: Mills and Boon, Ltd.) 1*s*.

The People's Books:—Atlas of the World. By J. Bartholomew. Pp. viii+56. The Nature of Mathematics. By P. E. B. Jourdain. Pp. iv+92. Friedrich Nietzsche. By M. A. Mügge. Pp. 94. Psychology. By Dr. H. J. Watt. Pp. 90. Zoology. By Prof. E. W. MacBride. Pp. iv+92. (London and Edinburgh: T. C. and E. C. Jack.) Each 6*d*. net.

Bartholomew's New Reduced Survey Maps for Tourists and Cyclists. Sheet 3: Cumberland. New and revised edition. (Edinburgh: J. Bartholomew and Co.) Paper, 1*s*. 6*d*. net; cloth, 2*s*. net; cloth, dissected, 2*s*. 6*d*. net.

Elementary Biology, Animal and Human. By J. E. Peabody and A. E. Hunt. Pp. xiv+212. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 4*s*. 6*d*. net.

The Chemical Constitution of the Proteins. By Dr. R. H. A. Plimmer. Part 2. Second edition.

Pp. xii+107. (London: Longmans and Co.) 3s. 6d. net.

A Study of Metabolism in Severe Diabetes. By F. G. Benedict and E. P. Joslin. Pp. vi+135. (Washington: Carnegie Institution.)

Pierre du Ryer, Dramatist. By Prof. H. C. Lancaster. Pp. v+182. (Washington: Carnegie Institution.)

Guide to the Materials for American History to 1783, in the Public Record Office of Great Britain. Vol. i., The State Papers. By Prof. C. M. Andrews. Pp. xi+346. (Washington: Carnegie Institution.)

The Classics of International Law. Edited by J. B. Scott. De Jure et Officiis Bellicis et Disciplina Militari Libri III. Vol i., Reproduction of the First Edition. With introduction by Dr. J. Westlake. Pp. xxvii+227. Vol. ii., Translation. By Dr. J. P. Bate. Pp. xii+250. (Washington: Carnegie Institution.)

Scientific Papers. By J. Y. Buchanan. Vol. i. Pp. xii+15 papers. (Cambridge: University Press.) 10s. 6d. net.

Klimatographie von Salzburg. By Dr. A. Fessler. Pp. 87+map. (Vienna: Gerold and Co.)

Report of the Conference on the Education of the Domiciled Community in India, Simla, July, 1912. Pp. iv+202. (Calcutta: Superintendent Government Printing, India.) 1s. 6d.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 13.

ROYAL SOCIETY, at 4.30.—A Cassegrain Reflector with Corrected Field: Prof. R. A. Sampson.—Studies of the Processes Operative in Solutions. XXV. The Influence of Non-electrolytes on Solubility. The Nature of the Processes of Dissolution and Precipitation: Prof. H. E. Armstrong and Dr. J. V. Eyre.—Studies of the Processes Operative in Solutions. XXVI. The Disturbance of the Equilibrium in Solutions of Fructose by Salts and by Non-electrolytes: E. E. Walker.—The Excitation of γ Rays by the α Rays of Ionium and Radiothorium: J. Chadwick and A. S. Russell.—Load Extension Diagrams taken with the Optical Load Extension Indicator: Prof. W. E. Dalby.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Factors in Parallel Operation: A. R. Everest.

CONCRETE INSTITUTE, at 7.30.—Three Steel-frame Structures in London: S. Bylander.

ROYAL SOCIETY OF ARTS, at 4.30.—Kathiawar: Sir W. Lee-Warner.

MATHEMATICAL SOCIETY, at 8.—Figures in n-Dimensional Space analogous to Orthocentric Tetrahedra: T. C. Lewis.—A Property of the ζ-Function: J. E. Littlewood.—The Summability of a Fourier's Series: G. H. Hardy.—Trigonometrical Series which Converge Nowhere or almost Nowhere: G. H. Hardy and J. E. Littlewood.—A Theorem Concerning Power Series: H. Bohr.—The Theorem of Quadratic Reciprocity: P. J. Heawood.—The Irreducibility of Legendre's Polynomials: J. B. Holt.

FRIDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 9.—New Gyroscopes and their Applications: Prof. Andrew Gray.

PHYSICAL SOCIETY, at 8.—Annual General Meeting.—The Dynamics of Pianoforte Touch: Prof. G. H. Bryan.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.—Modern Condensing Systems: A. E. Leigh Scanes.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

MALACOLOGICAL SOCIETY, at 8.—Annual Meeting.

SATURDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

MONDAY, FEBRUARY 17.

ROYAL SOCIETY OF ARTS, at 8.—The Art of Miniature Painting: C. Davenport.

ARISTOTELIAN SOCIETY, at 8.—The Analysis of Volition, treated as a Study of Psychological Methods and Principles: Prof. R. F. A. Hoernle.

VICTORIA INSTITUTE, at 4.30.—The Antecedent Probability of a Revelation: Ven. Archdeacon Sinclair.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Canals and Canalised Rivers: J. A. Saner.

TUESDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 3.—The Heredity of Sex and some Cognate Problems: Prof. W. Bateson.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Some Aspects of Palæolithic Relics in North Britain and Ireland: Rev. S. Smith.

ROYAL STATISTICAL SOCIETY, at 5.—The Panama Canal and Competition for Trade in Latin America, the Orient and Australasia: Prof. Lincoln Hutchinson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion:* Durban Harbour, South Africa: C. W. Methven.—Natal Harbour Works: C. J. Crofts.

ZOOLOGICAL SOCIETY, at 8.30.—Diagnoses of New Species and Varieties of Agnathous Mollusca from Equatorial Africa: H. B. Preston.—The Dwarf Buffalo of Southern Nigeria, with a Revision of the Dwarf Buffaloes of Western Africa: R. Lydekker.—Notes on the Habits of Certain Reptiles in the Lagos District: W. A. Lamborn.—Two British Entomostraca belonging to the Orders Copepoda and Ostracoda: Dr. G. Stewardson Brady.—The Gorgonopsia, a Suborder of the Mammal-like Reptiles: Dr. R. Broom.

WEDNESDAY, FEBRUARY 19.

ROYAL SOCIETY OF ARTS, at 8.—The Adulteration of Jam: E. Marriage.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Report upon the Lenses of the late Joseph Jackson Lister: E. J. Spitta.—Demonstration on the Use of the Centrifuge in Pond-life Work: D. J. Scourfield.—Slides showing the Development of the Fairy Shrimp (*Chirocephalus diaphanus*): C. Lees Curties.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Periodical Variations of the Velocity of the Wind at Oxford: W. H. Robinson.—Rate of Ascent of Pilot Balloons: J. S. Dines.—Meteorological Conditions in a Field Crop: W. L. Balls.

THURSDAY, FEBRUARY 20.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Studies on Enzyme Action. XIX. Urease, a Selective Enzyme. II. Observations on Accelerative and Inhibitive Agents: Prof. H. E. Armstrong, M. S. Benjamin, and E. Horton.—Nervous Rhythm arising from Rivalry of Antagonistic Reflexes; Reflex Stepping as Outcome of Double Reciprocal Innervation: Prof. C. S. Sherrington.—The Liberation of Ions and the Oxygen Tension of Tissues during Activity: Dr. H. E. Roaf.—Contributions to the Bio-chemistry of Growth. The Glycogen Content of the Liver of Rats Bearing Malignant Growths: W. Cramer and J. Lochhead.—Changes in the Glomeruli and Tubules of the Kidney accompanying Activity: Prof. T. G. Brodie and J. J. Mackenzie.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, FEBRUARY 21.

ROYAL INSTITUTION, at 9.—Horticultural Investigations at the Woburn Experimental Fruit Farm: Spencer U. Pickering.

SATURDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

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

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THURSDAY, FEBRUARY 20, 1913.

IMMIGRATION AND ANTHROPOMETRY.

Changes in Bodily Form of Descendants of Immigrants. By Prof. Franz Boas. Pp. xii + 573. (New York: Columbia University Press; London: H. Frowde, 1912.) Price 7s. 6d. net.

IN the year 1908 Prof. Boas, at the request of the United States Immigration Commission, began an investigation into the physical characteristics of immigrants. The volume under review contains an elaborate tabulation of the anthropometric data obtained, together with an analysis of the conclusions drawn from them. One of the most remarkable of the facts brought to light is the changes undergone in head form by the descendants of Hebrews and Sicilians. The cranial index of the former when born in Europe appears to be about 83; it sinks to 81 among those born in America. Among the latter, on the other hand, the index rises with the change of birthplace from 78 to more than 80.

It has been suggested, as a mechanical explanation of the relative lengthening of the Hebrew skull in America, that in Europe the babies of this race when very young are wrapped up in swaddling clothes so tightly that they cannot move themselves, and kept lying on their backs; that thus there is constant pressure on the back of the skull when it is in its most plastic condition, with the result that it decreases in length but increases in breadth. In America much greater freedom is allowed to the child, and it can lie as it likes, sometimes on its back, sometimes on its side; consequently, with the removal of the conditions which produce an artificial shortening a longer skull is developed. Prof. Boas examines and dismisses this hypothesis. One of the principal objections to it is that if it applies to the Hebrews it should apply to the Sicilians and Bohemians, who also keep their babies tightly swathed, but the relative length of the skull among the children of Sicilian and Bohemian immigrants decreases instead of increasing.

It has also been argued that the results obtained are due to the fact that the types of immigrants of each nationality have been changing gradually, but an examination of the cranial indices of Hebrews who immigrated at different periods from 1880 to 1910 show that the index is constant throughout this period, and in addition to this the difference between those who arrived in any particular year and their descendants is the same as that shown by a similar comparison involving the whole series.

The reality of the results is confirmed by the fact that the changes noted are more marked among those children who were born more than ten years after their mothers had arrived in the United States than among those whose mothers had arrived more recently.

Although the numbers dealt with are not very large, it is difficult to suppose that the results are due merely to chance, nor can they be attributed to what might be called a statistical accident. There does not appear to be any ground for deciding whether they are due to the influence of a changed environment or to the selective elimination of certain types. Prof. Boas inclines to the former view and urges that the onus of proof rests on those who hold the latter. They will probably be inclined to disagree with him on this point.

E. H. J. S.

PROBLEMS OF THE COTTON PLANT.

The Cotton Plant in Egypt. Studies in Physiology and Genetics. By W. Lawrence Balls. Pp. xvi + 202. (London: Macmillan and Co., Ltd, 1912.) Price 5s. net. (Macmillan's Science Monographs.)

THERE can be no doubt of the freshness and originality of mind with which Mr. Balls has attacked a great diversity of problems in their application to the cotton plant. Some of these questions are genetic, some pathological, some physiological in the stricter sense, and most of them involve considerations of direct economic importance.

Starting with the intention of improving the Egyptian cotton crop, the author found himself led on from one problem to another, and to the solution of each he makes a real contribution, often approaching to the dignity of discovery. His analysis of growth-rate and of the many influences which affect it is an illuminating piece of work, full of novel suggestions, and a botanical physiologist, looking for a line of work, might with profit follow up any of the various threads which Mr. Balls lets drop in his course.

The same is true of that part of the book especially relating to genetics. The F_2 generation was often of a most complex type, and by the application of a graphic method of analysis apparatus is introduced which may probably assist in the unravelling of other similar cases. In his study of the heredity of seed-weight, new and interesting ground is broken. It is shown that a form with seed actually light is genetically endowed with the capacity to form heavy seed, but, owing to the smallness of the boll, the seed does not become heavy. The problem of interference between factorial effects thus illustrated is one that, we are sure, awaits us in many comparable instances. Obviously, such interference might operate either by reducing the number of the seeds or by reducing their size; and in some plants, doubtless, the one effect will be found, and in other cases the other. The discussion of this and various other examples of complex results is unconventional and always fruitful.

The book is one which well illustrates the mental attitude of the investigator to whom problems appeal chiefly by virtue of their difficulty. Had Mr. Balls stuck to any one of the lines he has begun, no doubt he could have gone much further along it; but so soon as anything like a solution is in sight he would rather start another chase. This is not unfriendly criticism: for many who can follow there are few who can begin, and others will some day make something of the various beginnings here left unfinished. The real objection to this book is that it is in outward form at least a *book*. The only thread of coherence running through it is that the miscellaneous embryo treatises it contains were begotten in Mr. Balls's mind by the cotton plant. So, in the same way, the common fowl has been the point of departure for lucubrations on the origin of the mesoblast, on poultry-breeding for the table, on coccidiosis, on the food-value of cereals, &c., but though it may be good for a man to keep all these topics dancing through his own head, no real purpose is served by amalgamating them into one volume. It was to meet such cases that publication in journals was invented.

W. B.

THE ENERGY SIDE OF NUTRITION.

Nutritional Physiology. By Prof. P. G. Stiles. Pp. 271. (Philadelphia and London: W. B. Saunders Co., 1912.) Price 6*s*. net.

ALTHOUGH Prof. Stiles's little book is entitled "Nutritional Physiology," it is really an elementary treatise on the whole realm of physiology, though special attention is directed to digestion, absorption, and metabolism. Its keynote is the word "energy," and the living body is regarded from the point of view of an energy-transformer. The work is dedicated to Prof. Graham Lusk, of New York, and his influence can be easily traced in the chapters which deal with metabolism.

It is not possible to regard the book as a mere addition to the already numerous primers of physiology; it is something beyond this, although it makes no pretensions to being anything profound. It can be read with profit by the junior student, and still more by the senior student, and even the professed physiologist. Old truths are often put in new ways, and so fresh light is shed upon familiar problems. The language is often quaint and original, and the numerous analogies selected for explaining physiological truths are apt and well selected. Take the following as an example:

"The regulating action of the liver and the muscles upon the carbohydrate distribution may be paralleled, in part at least, by an analogy. Let us compare the active tissues to a mill turned by the waters of a stream. The water supply to the mill is to be compared with the sugar supply to the cells, which derive their energy from it. A meal is to the body as a storm is to the millstream—it adds to the volume of the power-producing element. The dam by the mill is like the kidney in its relation to the accumulated store," and so the parable runs on; it is unnecessary to quote more of it here.

The book contains the inevitable chapter on alcohol; this is written in a moderate strain, and may, perhaps, be viewed with disfavour by the extreme teetotaller because it is not intemperate. As one reads it, one almost feels that its author was writing it because he had to, but was protesting all the time inwardly against the American law which excludes all physiological books from scholastic institutions which do not obey the tyrannical behests of the party in power.

W. D. H.

CHEMISTRY: PURE AND APPLIED.

(1) *Fatty Foods, their Practical Examination*. A Handbook for the Use of Analytical and Technical Chemists. By E. R. Bolton and C. Revis. Pp. xii+371. (London: J. and A. Churchill, 1913.) Price 10*s*. 6*d*. net.

(2) *Der Kautschuk*. Eine kolloidchemische Monographie. By Dr. R. Ditmar. Pp. viii+140. (Berlin: Julius Springer, 1912.) Price 6 marks.

(3) *Modern Inorganic Chemistry*. By Dr. J. W. Mellor. Pp. xx+871. (London: Longmans, Green and Co., 1912.) Price 7*s*. 6*d*.

(4) *A First Class-Book of Chemistry*. By E. Barrett and Dr. T. P. Nunn. Pp. iv+124. (London: A. and C. Black, 1912.) Price 1*s*. 6*d*.

(5) *Elementary Applied Chemistry*. By L. B. Allyn. Pp. xi+127. (Boston and London: Ginn and Co., n.d.) Price 3*s*.

(6) *Trattato di Chimico-Fisica*. Traduzione Italiana con note del Dott. M. Giua. By Prof. H. C. Jones. Pp xx+611. (Milano: Ulrico Hoepli, 1913.) Price 12 lire.

(1) THE analytical examination of edible fats and oils is increasing in importance and in difficulty day by day. At least sixteen natural oils must be taken into consideration, and, when mixtures of these are presented for examination,

the task of determining their nature and origin is one that is almost beyond the range of ordinary analytical methods. In addition to the natural oils and fats it is necessary now to take into account the artificial products obtained by reducing them by hydrogen in presence of nickel; although these are only rarely mentioned, their preparation has already become an extremely important industry, which has grown to maturity at a very rapid rate and almost unobserved by the general public.

The "Handbook" of Messrs. Bolton & Revis has the merit of dealing with the examination of oils and fats exclusively from the point of view of their utility as food products. They have therefore been able to treat this branch of the subject with great thoroughness in a book of very modest dimensions. As they have had many years of experience in carrying out the tests which they describe, their conclusions are entitled to be received with respect and regarded as authoritative. This statement applies not only to their selection of the tests which are most suitable, but also to the rejection of others which are less suitable or even seriously faulty; as they remark in the preface, "omission of a method may often be better evidence of the knowledge of it than its presentation." The book is well illustrated and attractively printed; its utility will not be diminished by the fact that it has not passed through the hands of a literary editor, and bears the impress of the laboratory rather than of the classroom or the study.

(2) Dr. Ditmar's monograph on rubber is characterised by the scientific character of its treatment of a technical subject. At the head of the preface the statement is set out that "The essence of a colloid is instability: for this reason life is linked to the colloidal state. Πάντα ῥεῖ." The view of Heraclitus that "Everything is in a state of flux" is particularly applicable to the colloidal state, and has much to do with the inherent quality of "perishing," which is so serious a limitation to the usefulness of rubber. The importance of this "perishing" is shown by the fact that the author, in his chapter on the "Regeneration of Rubber," gives a list of nearly 200 patents, nearly all of which have been taken out during the last ten years.

Attention is directed to the great importance of the coagulation processes as affecting the nature of the product. In the case of synthetic rubber the aim must be to secure a highly polymerised product: the polymerised isoprene of the Elberfeld works possesses these qualities, but the polymerised butadiene resembles glue and can only be used as a "blender" or adulterant. It is impossible in a brief notice to discuss the vast amount of valuable information that has been brought together in this monograph, but it may be commended without reservation to the attention of all those who are interested in rubber, either as a technical product or as material for the study of colloid chemistry.

(3) Dr. Mellor's "Modern Inorganic Chemistry" is one of the most original of the text-books that have been published in recent years. Its very originality will probably limit its usefulness as a text-book for beginners, who would probably be well advised to acquire the rudiments of their knowledge from some more conventional source. But for a student who has already acquired a sound knowledge of inorganic chemistry, and is wondering in what way he may best add to it, it would be difficult to suggest a volume more calculated to impart new ideas and increased information than Dr. Mellor's book. It would serve admirably as a text-book of inorganic chemistry to cover the gap between the requirements of an intermediate and final B.Sc. examination.

The *four* crystalline forms of sulphur have at last been able to secure equal recognition in a text-book, and in the course of two pages the modern views of the composition of steel are effectively summarised. Little monographs such as these, embodying the results of recent researches, are of frequent occurrence and cover a very wide range of topics. On the other hand, the historical aspects of chemistry receive full recognition, nearly every statement of importance being accompanied by the name of the author who first discovered the facts and the date of the discovery.

(4) It is a matter of interest to receive a text-book of chemistry bearing on its title-page the names of a science master and an "examiner in education." The book that they have compiled is as a whole very logical and satisfactory, and includes incidental references to several phenomena which can be described in simple terms, but which have not previously found their way into elementary text-books. Amongst these the distillation of petroleum, the manufacture of linoleum, and the liquid-air process for separating oxygen may be mentioned.

The authors appear to be unaware of the historical aspects of their subject. There is really no need to use such a term as "soda gas" when Black's name of "fixed air" is available as a description of the gas which does not introduce prematurely to the student a statement of the presence of carbon in it. The authors have also been obliged to confess the illogical character of their action in describing the gas as "carbon *dioxide*" in chapter xvi. when they are unable even to attempt an explanation of the prefix until they reach chapter xxv.; even then they are not in a position to give any explanation which would be recognised as valid by any serious student of chemistry. Here again the lack of logical sequence might have been avoided by describing the gas as "carbonic anhydride"; even "carbonic acid gas" would be an improvement on "carbon dioxide" under the conditions imposed by the elementary character of the course.

(5) The American book on "Elementary Applied Chemistry" bears many signs of its country of origin, including a brief introduction written in the style of a "display advertisement." On the very first page of the book the student is required to make a note of his first chemical experiment as follows:

> Copy and sign the following statement: I hereby certify that a mixture called Tonsillitis Specific and examined by me contains
>
> Name
>
> Date

The mixture is one of sulphur and sugar, to be prepared *ad hoc* by the instructor. English readers may derive from this book considerable amusement and at the same time obtain a number of useful hints as to the possibility of introducing to youthful students the chief tests used in examining water, milk, baking-powder, &c.

(6) The Italian volume is a translation of the well-known American text-book, and will therefore not be likely to circulate in this country. It is well printed and is presented in an attractive form. T. M. L.

OUR BOOKSHELF.

The Theory of Evolution in the Light of Facts. By Karl Frank, S.J. With a chapter on Ant Guests and Termite Guests, by P. E. Wasmann. Translated from the German by C. T. Druery. Pp. xii+241. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1913.) Price 5s. net.

The object of this book, as stated in its preface, is to substitute "pure postulates" for those which are referred to as "postulates of the theory of evolution," put forward by "many students of nature at the present day." As examples of these precious *pure postulates* we may cite the following: (*a*) The oldest known fossils represent the beginnings of life on the globe (p. 22). (*b*) The absence of *all* the intermediate forms between great groups indicates a "transformation and alteration of form rather than an actual higher evolution" (p. 76). (*c*) "We are not justified in bringing animals, like mammalia, birds, fishes and worms, into genetic connection with plants, like trees, ferns, and mosses" (p. 108). (This, we are told in the preface, is the *chief postulate*.) (*d*) Explanation of the origin of life is essential to any theory of evolution (pp. 83–108).

Starting from these "postulates," there is no difficulty in forecasting the author's conclusions. Indeed, but for the fact that some recent researches are referred to in order that they may be tortured into support of the author's views, we might imagine that we were reading one of the reviews of the "Origin of Species" written fifty years ago; and this idea would be confirmed as we come upon contemptuous and vituperative references to Darwin, Haeckel, and other men of science. Not having seen the German original of the book, we cannot say whether the inaccuracies, which abound in every part of it, are due to the author or the translator. Within the compass of a dozen lines we find "Quartiary," "Mussel Chalk," "Dyas (Perm.) = Permian Limestone and Old Red Sandstone," and "Algonkium = pre-Cambrian." Nor are we impressed, as we wade through misconceptions, misstatements, and misspellings, by the fact that the book bears the *Imprimatur + Johannes J. Glennon Archiepiscopus Sti. Ludovici.*

The Story of a Hare. By J. C. Tregarthen. Pp. xi+199+plates. (London: John Murray, 1912.) Price 6s. net.

In this life-story of a hare the author has successfully combined narrative with instruction. Most books on natural history for general readers are too informative and lack the living feeling which always commands a wide appeal. This touch, which makes the whole world kin, is largely a thing of sympathy, and no book on the life of a wild animal can be successful without it. Mr. Tregarthen possesses that attribute and has therefore written a book which will be appreciated by all lovers of wild animals and observers of their habits. He describes the life of a hare from birth to death from the point of view of the animal itself, and amid the scenes of a century ago. We have thus an account of the hare's habits and its struggles for existence in an attractive setting. The author has insight as well as sympathy, and his book should interest many readers.

Les Progrès Récents de l'Astronomie. By Prof. Paul Stroobant. Pp. 173. (Brussels: Hayez, Rue de Louvain, 112, 1912.)

Prof. Stroobant's annual *résumé* of the advances made in astronomy during the previous year is becoming a work of increasing usefulness to the astronomical reader; a wide range of subjects is treated concisely and with a discerning appreciation of relative importance. As usual, the review of 1911 is not restricted to observations only, but includes the recent advances in theory, such, for example, as Miller's and Störmer's papers on the mechanics of the corona and Birkeland's suggestions as to the formation of sun-spots. Tables of new variable stars (148), minor planets (now totalling 732) and new spectroscopic binaries (94), and several fine plates, add considerably to the value of the work. W. E. R.

Heredity. By J. Arthur Thomson. Second edition. Pp. xvi+627. (London: John Murray, 1912.) Price 9*s*. net.

IN the present edition of his book, the original edition of which was reviewed in NATURE for August 20, 1908 (vol. lxxviii., p. 361), Prof. Thomson has included references to some of the new discoveries that have been made in the last five years in the branch of biology with which the volume is concerned.

An Elementary Historical Geography of the British Isles. By M. S. Elliott. Pp. x+172. (London: A. and C. Black, 1913.) Price 1*s*. 6*d*.

THIS little book shows very convincingly how profoundly the geography of a country can influence its history; and it serves to demonstrate also the necessity of a good knowledge of geography for teachers of history. The volume may be recommended as suitable for supplementary reading for boys and girls in secondary schools who are studying history or geography. The book is well illustrated and contains numerous helpful maps.

The Interpretation of Radium. By F. Soddy. Third edition. Pp. xvi+284. (London: John Murray, 1912.) Price 6*s*. net.

THE general characters of this work were given in the review of the first edition which appeared in the issue of NATURE of May 27, 1909 (vol. lxxx., p. 368). In the present issue Mr. Soddy has included the latest and most complete data available, and those new discoveries for which there is trustworthy evidence. A new final chapter upon the thorium and actinium series has been added.

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.]*

Iceberg Melting.

I HAVE pleasure in sending you a photograph of the iceberg around which we obtained the isothermal lines published in NATURE of December 12, 1912. I did not make an instrumental survey of this berg, but it was larger than the average of those met with in the Strait of Belle Isle. We sighted more than 200 bergs during our trip, and made traces of many of them. Invariably the temperature rose on the approach to a berg. Sometimes a small fall of temperature resulted abeam of the berg, but the rise of

FIG. 1.—Iceberg used for the purpose of studying the isothermal lines published in the issue of NATURE for December 12, 1912.

temperature was the one characteristic effect. The two other photographs [not reproduced] I send you illustrate the fantastic shapes seen in ice. I wish it were possible to furnish in some way an idea of the wonderful colouring, but I am totally unable to do so.

In the "swimming moose" you can see the dangerous overhanging ridge, which is caused by the underwater melting and the lapping of the warmer water waves against the ice. This ridge is always found in bergs which have not recently turned over. In the records which Mr. King was able to get for me in 1910, besides the rise of temperature, a fall of temperature was obtained, when the ship approached the various icebergs, with the exception of one. These bergs were all floating in the main arctic current off the eastern coast of Labrador. In the light of my recent work I feel sure that the drop in temperature was due to the influence of the cold current in which the iceberg was floating. These cold currents exist in the main arctic current, whether ice is present or not, but the effect of the presence of the ice is to elevate the temperature slightly.

To assist in illustration of my meaning reference must be made to the microthermogram taken on the Allan Line R.M.S. *Victorian* last June. This record, which is a direct trace from the chart on the instrument, is through the ice track at a depth of 18 ft. by the Cape Race route. After passing the "Cold Wall" the arctic current drops in temperature regularly as the ship proceeds westward. The small variations up and down are partly due to icebergs passed at distances of six to eight miles, and partly due to colder currents. The lowest temperature recorded here was reached nearest the Newfoundland coast, but the effect of ice can be seen well marked by the sharp peak of temperature, which I have shaded. Just here we approach it. I have many other traces illustrating the same thing, and for this reason I was forced to abandon the idea that an iceberg sensibly cools the water in which it is floating. I was also unable to find by calculation that an iceberg could appreciably influence the sea-water on account of its slow rate of melting.

It is very illusive to depend on laboratory tank experiments to illustrate sea-water circulation: the conditions at sea are very different. I was very much surprised not to find, during my experiments last summer, more conclusive evidence of sea-water dilution due to the melting icebergs. A large number of conductivity tests were made of sea-water, and these

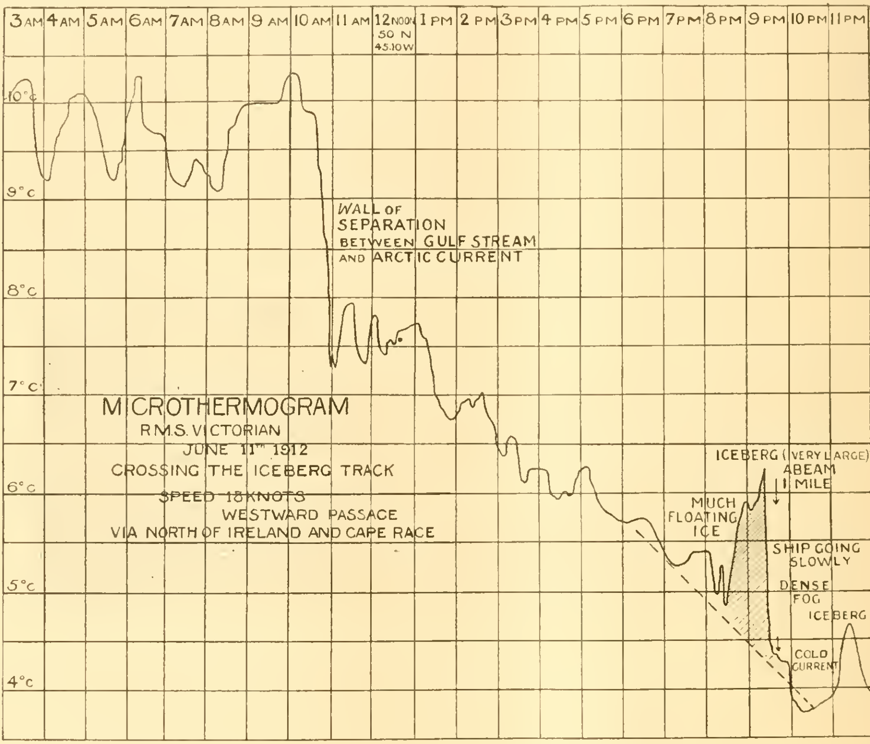

FIG. 2.

passed most of the ice closely, and were obliged to proceed slowly in heavy fog at times. This colder and swifter arctic current carried with it the greater proportion of the ice, but it is well known that this colder current exists whether accompanied by ice or not.

The great drop in temperature just before coming abeam of our largest berg was not due to the iceberg itself, but to the influence of the cold current. The effect of the ice is to hold the temperature abnormally high. The dotted line on the diagram represents how the temperature would probably have gone had no ice been present.

It would depend which way we approached this berg whether a drop in temperature would result. The temperature rises rapidly, whichever way we approach it.

are described in my Canadian Government Report. The following may be of interest; the readings were made at 26° C.:—

Table of Conductivities of Sea-water taken in July (1912).

Close to grounded berg, Cape Bauld Neld	0·05007
Strait of Belle Isle, eastern end	0·04827
Ten miles east of Belle Isle	0·04850
Close abeam large berg...	0·04787
One mile north of same berg	0·04806
Close abeam same berg	0·04827
Six miles from same berg	0·04768
Seventy yards to leeward of a berg	0·04787
Forty yards to windward of same berg ...	0·04787
One hundred yards to leeward of a berg ...	0·04806

The numbers may perhaps indicate a slight effect, but nothing like what I expected. My conductivity tests of the sea-water brought back by Mr. King from Hudson's Strait in 1910 gave a value of 0·0480 at 25° C. Correcting for temperature this observation serves to connect the sea-water entering the Strait of Belle Isle with that in Hudson's Strait. Eastward from Belle Isle Strait the conductivity rises rapidly for 180 miles, after which it becomes uniform up to 450 miles. The greatest arctic current sweeps down close to the Labrador shore, and in through the Strait of Belle Isle, where the resultant flow is westward. The following measurements of the conductivity through the ice track by the Belle Isle route were obtained last October on the *Empress of Britain*. The values were all measured at a uniform temperature of 25° C.

Abeam of Belle Isle	0·04865
Forty miles east of Belle Isle	0·04986
Eighty miles east of Belle Isle	0·05047
One hundred and sixty miles	0·05150
Two hundred miles	0·05235
Two hundred and sixty miles	0·05257
Four hundred miles	0·05211
Four hundred and fifty	0·05257

It is evident that the great arctic current is of a lower order of salinity, and that its course may be traced along our eastern coast.

In the early spring when the water is cold the Newfoundland fishermen will find the cod in the vicinity of the icebergs, and will always obtain their catch there. Perhaps this is an indication of the warming influence of the bergs, for the cod will not live in very cold water.

Next summer I shall continue my observations more particularly with reference to the influence of land on the temperature of the sea. I hope before long to be able to publish here some typical microthermograms showing this effect. H. T. BARNES.

McGill University, January 27.

Atmospheric Potential.

UNDER the above heading Mr. Evan McLennan refers in NATURE, February 13, p. 647, to supposed puzzles in atmospheric electricity. That certain difficulties exist no one can deny, but Mr. McLennan's difficulties might, I think, be removed by consultation of existing text-books. The vertical current which he thinks should exist in the atmosphere does exist, and methods of measuring it with more or less accuracy have been in operation for some years. Mr. C. T. R. Wilson devised an apparatus for its direct measurement, and his experiments, made in good weather near ground level, gave a mean value of about 2×10^{-16} amperes per sq. cm. A mean value of the same order, but slightly larger, has been deduced at Potsdam from continuous observations of the electric conductivity of the atmosphere and the potential gradient. To get an electrical current through a vertical conductor it is necessary to bring its upper end to the potential of the surrounding atmosphere. "St. Elmo's fire" is a well-known natural phenomenon. Currents can be obtained through a wire attached to a kite, but the experiment at times may be dangerous. Mr. McLennan seems to suppose that the potential in the free atmosphere increases uniformly with the height. Observations, however, have shown that the normal rate of increase of potential per unit of height diminishes as the height increases and becomes small at the height of a few kilometres. A mountain, it should be remembered, is part of the earth, and shares its potential; if steep it has a large effect on the shape of the equipotential surfaces in adjacent space. Dr. Simpson, in the letter referred to by Mr. McLennan, mentions the real poser, viz. why in spite of the vertical current the earth retains its negative charge in fine weather. C. CHREE.

The Ascent of the Italian Balloon "Albatross," August 12, 1909.

IN NATURE of August 19, 1909, a note appeared stating that in an ascent from Turin the Italian balloon *Albatross*, manned by Lieut. Mina and Signor Piacenza, had reached a height of 38,715 ft., which is greater by about 3000 ft. than any authenticated record for a manned balloon ascent. A communication has recently been received from Prof. Palazzo, director of the Italian Meteorological Office, in which he states that the aëronauts Mina and Piacenza were not provided with the necessary instruments for measuring the height which they reached, and that M. Mina, in the *Rivista Tecnica d'Aeronautica* of 1910, modified his earlier estimate and sought to prove that the balloon had reached a height of 9240 m. (30,300 ft.). Owing to the absence of a proper record of pressure and temperature, however, even that value is uncertain. W. N. SHAW.

Meteorological Office, South Kensington, London, S.W., February 12.

Induced Cell-reproduction in the Protozoa.

THE discovery of the fact that the products of cell death can cause cell-division in lymphocytes and other cells of the human body has given rise to a strong suspicion that these substances may be necessary for any form of cell-reproduction to occur. It has been already demonstrated by Fantham and Ross that *Amoeba coli* can be caused to divide through many generations by means of auxetics, and Drs. Ross and Cropper have shown that induced cell-reproduction will occur in the ova of *Ascaris megalocephala* if the eggs are mixed with a solution containing auxetics and incubated. It is important, therefore, for confirmation to come from other sources. Some time ago I was fortunate enough to discover a new variety of Polytoma, differing considerably from *P. uvella* in many respects, but chiefly in the fact that the new variety formed spores in the late autumn, which did not develop until the following spring. A full account of the new organism is in course of preparation for publication.

These winter resting spores seemed to me to be extremely suitable objects for testing the action of auxetics. Some preliminary experiments were accordingly made to see whether increase of temperature would cause development. Spores were placed under suitable conditions in the incubator, and kept at a temperature of 25° C. for periods varying from one to three weeks. On careful examination it was found, however, that no change had taken place.

A solution was then prepared containing 2 c.c. of a 4 per cent. solution of theobromine, 0·4 c.c. of a 5 per cent. solution of sodium bicarbonate, and 0·5 c.c. of a 1 per cent. solution of atropine sulphate, and the mixture diluted to 10 c.c. with water. Water containing large quantities of the spores was then mixed with an equal volume of this solution, and the mixture was incubated at 25° C. On examination at the end of forty-eight hours about 5 per cent. of the spores were found to show indications of division, while controls containing no auxetics showed no change. I then worked with a concentrated extract of sheep's suprarenal gland, augmented by the addition of 0·5 c.c. of a 1 per cent. solution f cadaverine to 10 c.c. of the extract. Incubation of spores with this mixture gave unmistakable evidence of division at the end of eight hours, and in forty-eight hours the products had separated, and were lying free within the sac wall. At a later period they acquired flagella, and several sacs discharged their contents, which appeared quite normal in all respects.

The fact that auxetics will cause the full development of these spores is important, and raises the question as to whether their presence may not be necessary under natural conditions, as it seems fairly evident that pond-water must contain auxetics, derived from the organic matter present, and it is quite possible that it may also contain augmentors in the shape of some of the alkaloids of putrefaction. Much work, however, remains to be done in this direction before the question can be regarded as definitely settled. From the available evidence, however, it seems to be clearly demonstrated that the products of cytolysis do cause cell-reproduction, and, that being so, it is very probable that it is absolutely necessary for a cell to absorb these auxetics before any reproduction is possible.

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The Lion in Sinhalese Art.

IN the notice of the new "Guide to the Collections of the Colombo Museum," which appeared in NATURE of January 9 (p. 523), the point was raised as to the source of the concept of the lion which occurs so frequently in Sinhalese art.

The lion has never been native of Ceylon, and the association of the symbol with the Sinhalese race may be traced back so far as B.C. 543, when a band of adventurers from northern India, led by Wijayo, landed in Ceylon. According to the *Mahawansa*, Wijayo's father was the offspring of a lion, and was called Sihabahu, or Sinhabahu (lit. "lion arm"). This legend is based upon the fact that the grandfather of Wijayo was probably an outlaw named Siha or Sinha ("lion"). Hence the name Sihala or Sinhala was given to Wijayo's kingdom, and the newly established race became known as the Sinhalese. In this way the lion became the national emblem, and, together with the sun, is depicted on the royal banner. Nevertheless, there is no Sinhalese heraldry, as the term is understood in Europe.

The lion was regarded as a symbol of royalty by the Sinhalese, hence the word *sinhāsena* (lit. "lion seat") was applied to the throne. In the Colombo Museum there is a stone lion standing about 5 ft. high, upon which was placed the throne of the kings when the seat of Government was at Polonnaruwa.

A monograph on the Sinhalese banners is shortly to be issued from the Colombo Museum, when the significance of the lion will be fully discussed.

JOSEPH PEARSON.

Colombo Museum, Ceylon, January 30.

THE BRITISH ANTARCTIC EXPEDITION.

(1) TRIBUTE TO THE DEAD EXPLORERS.

FULLER information and reflection on the disaster which overtook Captain R. F. Scott and his four companions in the Antarctic have served to intensify the national senses of bereavement at their end and of pride at the manner in which it was encountered, and both senses have been given full expression. St. Paul's Cathedral was filled, and might have been filled again, on Friday last, when a memorial service was held. The King was present, and there also attended Queen Alexandra, the Prime Minister, and other members of the Government, representatives of the Opposition, of foreign Powers, of the Royal Geographical Society, of the Royal Society, and of many other bodies and institutions which were directly interested in the expedition, or with which its lost members were associated. Memorial services have also taken place at Portsmouth and Devonport dockyards and elsewhere. Expressions of regret have been received from many Colonial and foreign Governments and societies, and tributes of deep sympathy and appreciation have been paid to the memory of the dead by other workers in the polar fields—Dr. Nansen, Admiral Peary, Captain Amundsen, Dr. Charcot, Sir E. H. Shackleton, and others.

Prompt steps have been taken to fulfil the last wish of Scott, that those dependent on his companions and himself should not be allowed to want. On the part of the Government, it is stated that Captain Scott and Petty Officer Evans will be regarded as having lost their lives in action, and the pension due to their widows will consequently be enhanced. Further assistance, covering the necessities of the dependants of the other lost travellers, may be expected to be forthcoming from the public funds. The committee of the Antarctic Exploration Fund, of which Sir Edgar Speyer is chairman, is taking measures to the same end, and is also concerned to clear off the very heavy debt remaining upon the expedition, towards which Scott himself had pledged personal property, and which includes the recoupment of some of the survivors who have forgone part of the payment due to them. The question of the proper publication of the scientific results of the expedition is also involved. If the expedition had ended in success unshadowed by disaster, and if the leader had himself returned, means would have been open, which now are closed, for the discharge of these liabilities; the loss of his lectures, for example, must have a serious financial bearing on the whole position of affairs. In addition to the action of the Government and of the committee, a public subscription fund has been opened by the Lord Mayor of London; two London newspapers (*The Daily Telegraph* and *The Daily Chronicle*) have adopted a similar course, and collections are also being made under various official or unofficial auspices in various centres in the provinces and colonies. It may be added that, at the moment of writing, the Mansion House Fund has not been augmented with the rapidity characteristic of occasions of deep national feeling; it may well be that the public waits to learn what measures will be taken by the Government; but these cannot in the nature of the case be taken immediately, and there is ample scope for the proper use of whatever moneys may in the meantime be subscribed.

In addition to the above connections in which money is needed, a specified object of the Mansion House Fund and of some others is the provision of a national memorial to the dead. From such an object none can conceivably dissent; a generation which has recently criticised those preceding it for neglecting to set up a proper memorial to Captain James Cook could scarcely face the chance of incurring similar criticism in the case of Captain Scott; but the question of the form which should be taken by a national memorial is wide, and always involves much discussion and invokes many opinions. In all the present circumstances, however, much respect and consideration are due to a suggestion which emanates from Lord Curzon, who, as president of the Royal Geographical Society, addressed a letter to the Press on Saturday last, summarising the whole position as, but more fully than, it has been summarised above. In his concluding paragraphs he discusses the question of the form of a national memorial to Scott and his companions. "A national monument in a public place," "a memorial in our great metropolitan cathedral," are the suggestions which would come first to the minds of most men, but Lord Curzon qualifies them with the counter-suggestion that "the available sites for public monuments in London are few; nor does our artistic genius invariably find its best expression in masses of marble or bronze." Many would agree with this view, and might feel that some measure of more practical utility, such as the endowment of future scientific research in the Antarctic or Arctic region, would be a more fitting memorial to those who gave their lives in the advancement of that particular department of research.

Lord Curzon's suggestion, however, made on behalf of the Royal Geographical Society, is for the erection of a Scott Memorial Hall on a portion of the ground belonging to Lowther Lodge, which has recently been acquired by the society as the headquarters where it will very shortly be established. The society has hitherto held its large meetings in the theatre at Burlington Gardens; but since the Lowther property was acquired the ultimate provision of a hall of its own has been in mind. The disaster to Scott is an incident not only in national history, not only in the history of exploration, but in the history of the society itself; it befalls to synchronise with two other important incidents, the establishment of the society in new quarters and the broadening of the basis of its membership; on such grounds there is reason for a hope that the proposal for a hall specially devoted to lectures on geographical science and exploration should be fulfilled more speedily than in the normal course it would probably be, and should be identified with Scott's name; and it may well be suggested that the establishment of such a hall would be a most fitting form of national memorial, combining at once the public function fulfilled by statuary and the scientific function of a foundation for the advancement of geographical research. A national memorial of such form could be entrusted to no more fitting keeping than that of the society which is the representative of the nation in the promulgation of geographical discovery, and has been so closely associated with the British Antarctic Expedition itself.

The scientific importance of the expedition, to which brief reference was made last week on the basis of the information which had been brought from the expedition last year, is immensely enhanced by the further results which Commander E. R. G. Evans has now summarised. First, it is a duty to pay one further tribute to the personal devotion to their scientific duties of Scott and his dead companions, for not only does it appear that through all the dreadful stress of the return march from the pole, down to March 12 (1912), when the thermometer was broken, they maintained meteorological observations, but it is reported also that they carried with them to the end a collection of geological specimens, a dead weight which they must often have been tempted to jettison; many would have done so, and none would have blamed the act. Commander Evans lays stress on the geological results of the expedition at large; and the main points of these results are referred to below. Investigations of the physical conditions of the ice were continued; these, together with meteorological, magnetic, gravity, and atmospheric electrical observations occupied Mr. C. S. Wright, while Mr. E. W. Nelson carried on hydrographic work; Mr. Cherry Garrard dealt with the preparation of skins of zoological specimens, and Mr. Lillie with marine biological collections. A new line of soundings is mentioned, extending from Banks Peninsula to 60° S., 170° W., and thence to 73° S., and an abrupt shoal, with only 158 fathoms' depth above it, is recorded in the middle of Ross Sea.

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(2) Geological Results.

The dispatch from Commander Evans published on February 15 deals especially with the geological results of the expedition; they were collected by the southern party under Captain Scott, by the northern party under Lieutenant Campbell—who was accompanied by Mr. Raymond Priestly as geologist—by the western party under Mr. Griffith Taylor, and by Mr. Priestly during the ascent of Mount Erebus in December, 1912. It is clear that each party secured most interesting and valuable information. All the parties have been working in areas that had been previously traversed by members of the National Antarctic Expedition, or by that under Sir Ernest Shackleton. It had been hoped that one party would have visited King Edward VII. Land, and have discovered the structure of the lands to the east of the Ross Sea, which were quite unknown until reached by Nansen's companion Johansen, who was serving with Amundsen. The abandonment of this project enabled the energies of the whole of Captain Scott's staff to be devoted to the further study of South Victoria Land.

Commander Evans's despatch is written in popular language, and the results cannot be judged until the receipt of a more technical statement. The difficulty of interpreting the cablegram is increased by some obvious verbal errors; thus the statement that in the volcanic series at Cape Adare "there was found an agglomerate of erratic bearing, many of the boulders being striated by ice action," is unintelligible. If it means that the old rocks there include a conglomerate of ice-scratched boulders, the discovery would be of much interest, especially if its age can be determined; it may mean that the volcanic rocks include an agglomerate, and that there is also a glacial boulder bed.

Commander Evans reports that the southern party brought back 35 lb. of geological specimens, which were apparently all collected from the Beardmore Glacier. The report published shows that this material confirms the conclusions based on the specimens collected by Sir Ernest Shackleton. His party observed seven seams of coal in

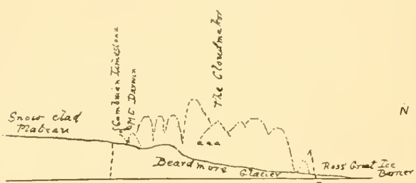

FIG. 1.—F, Faults bounding the mountain Horst. .r, Coal seams in beacon sandstone. *a a a*, Limestone breccia with Archeocyathus, Ethmophyllum, Solenopora, etc.

the cliffs at the head of the Beardmore Glacier: one seam was 7 ft. thick, and four were each 3 ft. thick. The coal contained 69 per cent. of fixed carbon, and the sample tested was non-coking. The seams occur in the Beacon Sandstone, and the plant remains indicate that the age of this formation is either Upper Palæozoic or early Mesozoic. The fossil plants obtained by Dr. Wilson appear to be in better preservation, and it is therefore interesting to find that they confirm the age assigned to the Beacon Sandstone by Prof. David and Mr. Priestly. The other fossils obtained by the southern party are described as "corals of a primitive form, typical of the early Palæozoic Age." The Cambrian fossils obtained from the same locality by Shackleton include a coral allied to Ethmophyllum, and specimens of Archæocyathus, Coscinocyathus, Solenopora, as well as sponge spicules and traces of Radiolaria. The accompanying section (Fig. 1) from the report by Priestly and David shows the relative positions of the Cambrian and coal-bearing formations. The specimens of Cambrian limestones obtained by the southern party will probably yield important additions to the small Cambrian fauna collected by Sir E. Shackleton.

The northern and western parties have both been at work in areas of which preliminary surveys have been made by the two previous expeditions, and they will no doubt add materially to knowledge of the area. The recovery of Prof. David's collection from Depot Island will probably enable him to fill in further details to his work.

Mr. Griffith Taylor, of the Australian Meteorological Service, who was geologist to the western party, has examined a coal seam in the Beacon Sandstone near Granite Harbour, while Mr. Priestly has studied the same formation near Mount Melbourne, and there obtained some large stems of fossil wood. These new plant remains should enable the age of the Beacon Sandstone to be more definitely established. Prof. David describes the formation as similar to the "Trias-Jura" of Tasmania, but he regards the evidence as only adequate to assign it to the Gondwana Formation; and it may therefore be as early as the Carboniferous or as late as the Jurassic.

The detailed survey by Mr. Priestly and Mr. Taylor will no doubt be found to yield more new information to the geology of South Victoria Land than is implied by the dispatch. Their work, for example, will probably settle the question at issue between the two former expeditions as to whether any of the granites are intrusive into the Beacon Sandstone.

It is also announced that the volcano rocks of "Rock Island," clearly a misprint for Ross Island, have been discovered to be older than was thought.

Mr. Priestly during the first season collected a series of rocks from the Cape Adare district, which was previously known from the collection made by the Southern Cross Expedition, and described by Dr. Prior. Mr. Priestly also ascended Mount Erebus by a different route from that followed by Prof. David; the lip of the crater was found to be 10,000 feet high, and the sledges were hauled to the level of 9500 feet. The volcano was in "mild eruption," and Mr. Gran was nearly suffocated by its fumes.

Mr. Griffith Taylor has measured the flow of the Mackay Glacier, and found that its rate is 80 ft. a month, a much lower speed than that of some Greenland glaciers, and less than that estimated for the Ross Barrier. With so competent a physiographer as Mr. Taylor, valuable contributions to the glacial geology of the area may be confidently expected.

Commander Evans's report directs attention to the interesting problem of former changes in the Antarctic climate. As the rich fauna living in the Ross Sea includes simple corals and sponges, the fossils from the Cambrian limestones do not prove any considerable change in the temperature of the Antarctic seas. The fossil plants and coal seams give stronger evidence than the fauna of climatic change. It is interesting to know that the Antarctic shared in the variations of climate proved for the Arctic regions by their well-known plant beds; but the extent and nature of the climatic change indicated by the Arctic fossil plants is still problematical.

EXPERIMENTAL STUDIES IN AËRO-DYNAMICS.[1]

M. EIFFEL has contributed much to the experimental study of aërodynamics and aëronautics, and his experiments at the Eiffel Tower some years ago upon air resistance at high velocities will be recalled as establishing the truth of the squared law for velocities up to 40 metres a second. His subsequent researches at his laboratory in the Champ de Mars will be familiar to all students of the subject, and more particularly to those concerned with the more practical aspects of aërodynamics as pertaining to the design of aëroplanes. In this paper he describes some recent researches, and also the apparatus and equipment at his new laboratory in the Rue Boileau, Auteuil, which the writer has had the opportunity of inspecting, thanks to the courtesy of M. Eiffel and of M. Rith, his able collaborator.

This laboratory was designed on a more extensive scale than that of the Champ de Mars, for the wind tunnel in the latter only allowed velocities of 18 metres a second. As the speed of aëroplanes considerably exceeds this, it was deemed advisable to construct new apparatus to obtain velocities more nearly those attained in actual flight. The large wind tunnel in this laboratory consists of a tube provided with a fan, the tube being made on the Venturi pattern, and in that part corresponding to the "throat" is situated the room containing the delicate registering apparatus, in which the attendants can watch and work the tests upon aërofoils of large size suspended in the current (Fig. 1). The current traverses this room, the outlet and inlet being on opposite sides. The cone collector has diameters of 4 and 2 metres with a length of 3·30 metres, and the diffuser (or discharge end of the tube) has a length of 9 metres and ends with a fan 4 metres in diameter (Fig. 2). With this large tunnel velocities of 2 to 32 metres per second are obtained.

Parallel with this tube, and passing through the same instrument or measuring room, is another, 1 metre in diameter, by which velocities of 40 metres per second (89 miles per hour) can be obtained. The registering apparatus is carried upon a chariot running on rails, and may be moved from one tube to the other, as desired, across the instrument room. So much for the design of this laboratory, at present the largest of its kind in existence, and very complete in all that pertains to experimental aërodynamics.

The first tests made at the Auteuil laboratory and described in the paper before us were upon model aëroplanes to determine, if possible, the laws of similitude between an aëroplane and its model. For this purpose an *exact* model, constructed to a scale of 1 to 14·5, was made of the aëroplane used by Col. Bouttieaux and M. Meudon, of the military aëronautical laboratory at Chalais-Meudon, for experimental purposes and equipped with registering apparatus. By pressing a button the pilot, Lieut. Saunier, when flying on an absolutely calm day, could register photographically the following data:—(1) the kinetic thrust of the propeller, or head resistance, usually called "drift"; (2) the speed of the propeller; (3) the velocity of the aëroplane relative to still air; (4) the angle of attack or angle made by the chord of the aërofoils with the line of flight.

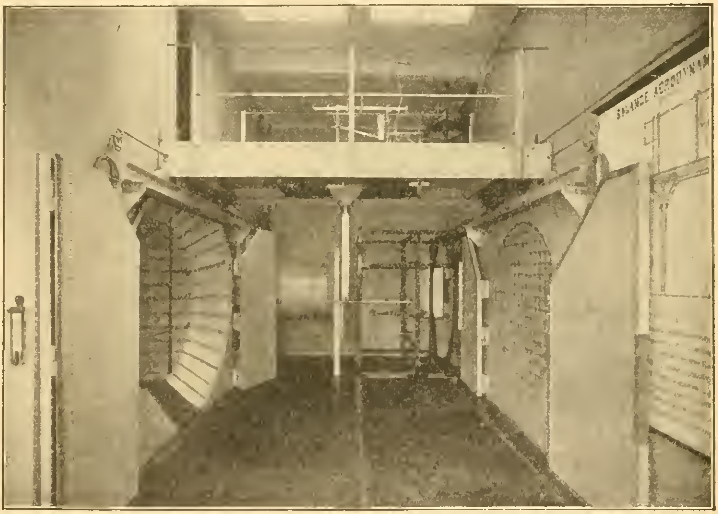

FIG. 1.—Dynamometer room through which the current of air passes from right to left (Auteuil laboratory).

The model of this aëroplane was subjected to tests in the laboratory at velocities about the same as those of the actual flight, and curves were drawn giving the values of lift and drift for different angles of attack. When these resistances, horizontal and vertical, are compared for the aëroplane and its model, they are found to

[1] "Les nouvelles recherches expérimentales sur la Résistance de l'Air et l'Aviation faites aux laboratoires du Champ de Mars et d'Auteuil." Par M. G. Eiffel. Extrait des Mémoires de la Société des Ingenieurs Civils de France. (Bulletin de Juillet, 1912.)

lie on the same curve, taking account, of course, of the scale of the model. All the values of the vertical components for the aëroplane fall exactly upon the curve for the model, and five out of seven for the horizontal components likewise, the other two showing but slight difference. The paper contains other results obtained in this new laboratory from which much may be expected in the future.

In his paper[2] M. Gandillot makes frequent calls upon the experimental results obtained by M. Eiffel to support the mathematical analysis he gives of the action of bodies moving through the air and the thrust of aëroplane propellers. He considers the air as an elastic medium in which disturbances are propagated according to well-known laws. The mass of air acted upon by a plane surface moving through it may be calculated by these considerations, and the deductions are supported by M. Eiffel's results. Thus a plane surface moving at a constant velocity at a known gradient acts upon a mass of air greater than the volume swept through, as is shown by the fact that the force necessary to move the plane is greater than would be accounted for by displacement. In the light of the experiments of M. Eiffel on propellers in a current of air, the discussion of the action of propellers during flight is interesting, especially the law connecting speed of flight with angular velocity of propeller. This mathematical summary is a valuable work taken in connection with the researches at the Champ de Mars and Auteuil.

R. S. B.

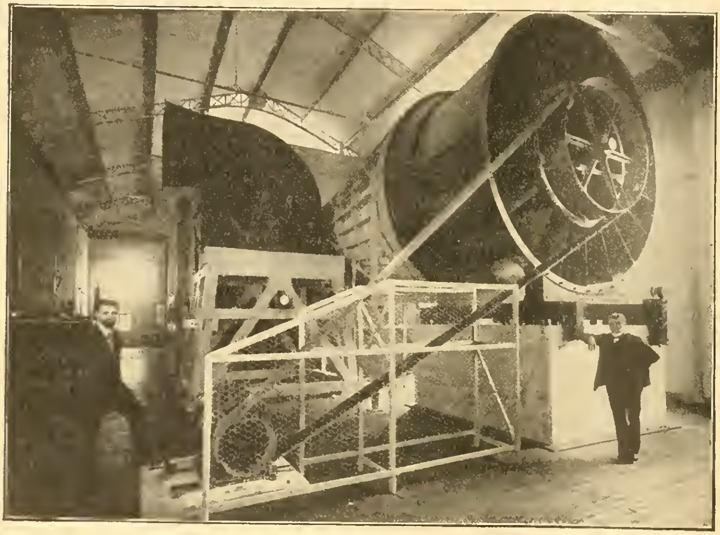

FIG. 2.—Discharge end of the Venturi tube (Auteuil laboratory).

[2] "Abrégé sur l'Hélice et la Résistance de l'Air." Par Maurice Gandillot. (Paris: Gauthier-Villars.)

THE WHEAT SUPPLY OF GREAT BRITAIN.

THE recent announcement by Mr. R. H. Rew that this country produces about one-half of its own food lends interest to the volumes of statistics periodically issued by the Board of Agriculture, setting forth the respective amounts of agricultural produce raised at home and imported from abroad, and the home production of agricultural produce. Even those who professed to be experts in the matter were not prepared to find that so much of our food was home-grown. There is no doubt that the wheat statistics had been responsible for the misconception. Only about one-fifth of our wheat is supplied by the British farmer, the rest all coming from abroad. It had been too hastily assumed that the other imports of food supplies worked out in the same proportion.

In the latest figures published in the Journal of the Board of Agriculture (No. 6, 1912), it is shown that the home crop amounted to more than 8 million quarters for the previous season (1911–12). Although this is far below the 10 million quarters raised in 1885, it is, nevertheless, the highest crop obtained for many years, a highly satisfactory result on which agriculturists are much to be congratulated. The total imported was roughly $27\frac{1}{2}$ million quarters, which came most from India, next from Canada, followed by the United States, Argentina and Australia, and least (among the principal countries) from Russia. One of the most remarkable developments has been the Indian supply. So recently as 1908–9 India came rather a bad fourth on the list of wheat-supplying countries, Canada third, and the Argentine and the United States respectively first and second. But the Indian export made a big jump up in 1909–10, and a further one in 1910–11, and it maintained this new high level in 1911–12.

So much admirable work has been done at Pusa on the production of Indian wheats for the British market, and so much interest has been aroused among the more progressive cultivators, that we may confidently expect India to maintain a high position among wheat-producing countries.

Canada is, however, running India very close, and the staff of the Ottawa Experimental Farm is actively engaged in studying wheat production, in raising new varieties suited to the different regions, and in devising new methods of management or cultivatio. likely to increase the yield. It is satisfactory, also, to find that Australia has considerably increased her shipments of wheat and sent more than in any previous year; the yields for some of the States would seem to indicate even further possibilities of increase.

GEORGE MATTHEY, F.R.S.

THE death of Mr. George Matthey, F.R.S., on February 14, in his eighty-eighth year, removes one who whilst actively engaged in commercial work was at the same time keenly interested in scientific progress.

During the early years of his life Mr. Matthey's time was devoted not only to developing and extending the business in Hatton Garden, but also to a most careful study of platinum and its associated metals, and he devised methods by which these metals could be separated quantitatively from each other on a large scale. These methods were described by him in the Proceedings of the Royal Society for 1879 (vol. xxviii., p. 463).

In 1870 an international metric commission met in Paris. Its object was the construction and verification of a new and uniform series of standards, and upon it served such masters of metallurgical and chemical arts as Deville, Debray, and Stas. Certain members of the commission undertook the work of purifying the platinum and iridium of which the new standards were to be composed.

After much labour had been expended, the alloy consisting of platinum with 10 per cent. of iridium was produced, but on analysis it was found to be impure. At this stage Mr. Matthey was invited by the French Minister of War, at the instigation of several important official bodies, to prepare the necessary quantity of alloy. He at once undertook the work of making the large quantities of platinum and iridium in the highest state of purity, and finally cast the ingots of the alloy in Paris. These ingots were submitted to the most rigid analysis, and proved to be exactly of the composition required.

Mr. Matthey was then invited to construct the bars of the somewhat peculiar cross-section which had been already decided upon. The writer well remembers Mr. Matthey telling him that his friends besought him to have nothing to do with the construction of the bars; he was not, however, a man to be daunted by a difficulty of this sort, and he went into the City and bought a second-hand lathe, and set one of his skilled workmen to produce the bars of the desired cross-section. The bars fulfilled all the conditions that were laid down. Copies of them were supplied to all the larger countries of the world, and they now constitute the standards upon which the metric system rests. Mr. Matthey was appointed a member of the Legion of Honour, and in 1879 he was elected a fellow of the Royal Society.

Notwithstanding the absorbing character of business affairs and inroads on his leisure necessitated by his deep interest in scientific progress, Mr. Matthey found time to interest himself in educational matters; he played a very active part in the foundation of the City and Guilds Colleges for the advancement of technical education at Finsbury and South Kensington, and served for many years on the executive governing body of those institutions. His wide knowledge of affairs and his keen judgment of men played no small part in determining the signal success of these two colleges from their very inception. The very complete scheme of technical education with which London is provided is in a large measure due to the enthusiastic efforts of Mr. Matthey in association with two other prominent members of the Goldsmiths' Company, Sir Walter S. Prideaux and the late Sir Frederick Abel.

Mr. Matthey for a very prolonged period served as a warden of the Goldsmiths' Company, where his counsel and advice were of the greatest assistance on questions relating to assaying and the precious metals. Almost all who work at scientific research are under a deep debt of gratitude to Mr. Matthey and his firm for unvarying kindness in helping them out of many difficulties by placing the resources of their works so freely at their disposal.

Those who had the privilege of counting Mr. Matthey as a friend realise that they have lost a truly delightful companion, remarkable not only for the wide breadth of his sympathies, but also for his genial temperament and abhorrence of all that savoured of sham.

C. T. H.

NOTES.

MR. DAVID HOOPER, curator of the Industrial Section, Indian Museum, Calcutta, has been appointed economic botanist to the Botanical Survey of India.

THE Rev. A. H. Cooke, author of an important work on molluscs ("Cambridge Natural History Series"), has succeeded Mr. R. Bullen Newton in the presidency of the Malacological Society of London.

THE Toronto correspondent of *The Times* states that the Dominion Government will grant Mr. Stefansson the sum of 15,000*l*. towards his expedition into unexplored territory north of the Canadian mainland. Mr. Stefansson will take with him Canadian students with scientific knowledge, and the expedition will be directly under the Canadian Geological Survey. He expects to be absent three winters and four summers.

DR. W. J. G. LAND, assistant professor of botany at Chicago University, has recently spent four months in investigations in Australia and the Samoan Islands. Two of these months were occupied in the collection and study of plants in the island of Tutuila, where the remarkable growth and variety of the ferns attracted special attention. Dr. Land also made observations in and around the crater of Kilauea in the Hawaiian Islands.

The Geographical Society of Philadelphia has hitherto been accustomed to present its Elisha Kent Kane gold medal to explorers only. This year, however, it has made an innovation by bestowing that honour, the highest in its gift, on a distinguished geologist, Prof. W. M. Davis, of Harvard. The presentation immediately preceded a lecture by Prof. Davis on human response to geographical environment. This was the first of a series of memorial lectures to Angelo Heilprin.

On Tuesday next, February 25, Prof. H. H. Turner will begin a course of three lectures at the Royal Institution on the movements of the stars, and on Thursday, March 6, Mr. W. B. Hardy will deliver the first of two lectures on surface energy. The Friday evening discourse on February 28 will be delivered by the Hon. R. J. Strutt on active nitrogen, and on March 7 by Mr. C. T. R. Wilson on the photography of the paths of particles ejected from atoms.

The Paris correspondent of *The Times* reports that preparations are being made for the dispatch of an official French expedition to Franz Josef Land under M. Jules de Payer, son of the Austrian Captain de Payer, who commanded the Austrian expedition that discovered Franz Josef Land in 1873. The object of the expedition is to explore the little-known northeastern portion of Franz Josef Land. A base will be established in the archipelago formed by Zichy Land, Liv, Eva, Adelaide, and Hvidtenland Islands. M. de Payer proposes to pass the winter at the base in scientific observations and in preparation for summer work, when a varied programme of scientific investigation will be executed by means of two aëroplanes and a boat fitted with auxiliary power.

A bequest of 100*l.* was left to the Linnean Society by the late Sir Joseph Hooker. The council of the society desires that the bequest should form the nucleus of a fund to be raised for the endowment of a Sir Joseph Hooker lecture, to be delivered every second, third, or fourth year, and to be published by the society. The proposal meets with the warm approval of Lady Hooker. A total sum of not less than 600*l.* should be obtained for this purpose, and the council confidently appeals to the fellows of the Linnean Society and others to contribute. Cheques should be drawn in favour of the "Hooker Lecture Fund," and sent to the general secretary of the Linnean Society, Burlington House, London, W.

The Board of Trade and the principal Atlantic steamship lines are to cooperate in carrying out during the present year the recommendations of the Merchant Shipping Advisory Committee in its report on life-saving at sea as to stationing an ice observation vessel to the north of the steamship routes across the North Atlantic. Following the advice of a conference summoned by the Board of Trade to consider the best means of giving effect to this recommendation, it is proposed this spring to station a vessel off the east coast of North America to the north of the steamship routes to watch the break up of the ice and to report its movement. The *Scotia*, formerly employed on the Scottish Antarctic expedition, has been chartered, and it is anticipated that she will be ready to leave about the end of this month. The vessel is being fitted with a Marconi wireless installation of long range to keep in touch with the wireless stations in Newfoundland and Labrador. The cost of the expedition will be shared between the Government and the principal Atlantic steamship lines. There will be three scientific observers on the vessel, and as she will be from time to time stationary, it is expected they will make oceanographical and meteorological observations of general scientific interest, as well as of direct value to the work in hand.

The Herbert Spencer lecture at Oxford was delivered on February 14 by Prof. D'Arcy Thompson, He began by paying a warm tribute to the memory of Spencer, laying stress on the widespread nature of his influence—an influence that had more effect upon contemporary thought than even that of Kant in a former generation. With no education in literature or art, and without advantages of style, he was yet "a gallant soldier in the cause of intellectual freedom." Passing on to the special subject of his lecture, viz. "Aristotle as a Biologist," Prof. Thompson drew a graphic picture of the natural surroundings of Aristotle during his two years' residence at Mitylene —the period to which, in the opinion of the lecturer, the bulk of his work in natural history is to be attributed. Many reasons of weight were given in favour of the view that in the fauna, and especially the marine fauna, of Lesbos and the neighbouring seas and islands, Aristotle found the chief material for his anatomical researches. This was important in relation to the fact that it limited the date of his chief philosophical works to a time subsequent to the writing of his treatises on biology. Plato "saw as in a vision," but Aristotle was neither artist nor poet, nor, it was to be suspected, a profound mathematician. But he was a naturalist born and bred, and, above all, a student of life itself. His biological instincts and training unmistakably influenced his philosophy. This was apparent alike in his politics, his psychology, and his ethics. In all these his treatment was scientific. Making full use of the comparative method, he yet stopped short of a complete historical conception of evolution.

The widespread belief in the sanctity of the fig-tree, which, as the *pipal* (*Ficus religiosa*), is venerated in India, is illustrated by the account contributed to the January issue of *Man* on the cult of the tree by the A-Kikuyu of East Africa. The exact species of this tree has not been as yet determined, but Mr. W. H. Beech describes it as the medium by which prayers ascend to Ngai, the tribal deity. As is the case with its Indian congeners, the wood is used to make the fire-drill, and the identity of observances connected with the tree seems to suggest a fusion of Indian with East African culture.

We have received from Capt. Stanley Flower a revised list of the zoological gardens and menageries of the world, published apparently at Cairo. The total number is 168.

Vol. iv., No. 2, of *Meddelelser fra Kommissionen for Havundersøgelser, serie: Fisheri*, is devoted to an account by Dr. J. Schmidt of the early ("preleptocephaline") larval stages of congers and certain other eels. It is claimed that this is the first definite identification of some of the earliest stages of the species in question, and therefore the first trustworthy clue to the particular kinds of muraenoids which spawn in the Mediterranean. All the larvæ have pectoral fins, even in cases where these disappear in the adult. They may be divided into two groups, according to the absence or presence of swellings in the intestine, and the even distribution or collection into groups of the pigment cells. To the first group belong *Conger vulgaris*, *C. mystax*, and *Muraena helena*, and to the second *Nettastoma melanurum*, three species of Ophichthys, and a new form, described as *Leptocephalus telescopicus*. The three species of Ophichthys and the Leptocephalus spawn in winter, instead of, like the rest, in summer.

Dr. S. Kusano has published (Journal of the College of Agriculture, University of Tokyo, iv., No. 3) an account of the life-history and cytology of a new species of Olpidium, which is of great interest with reference to the affinities of the Chytridiales, an extremely lowly group of fungi. The most remarkable feature in the life-cycle of this new form is that some of the swimming reproductive cells (zoospores) regularly copulate in pairs to form a zygote. In discussing the difficult question of the affinities of this remarkable group of organisms, the author inclines to the view that their origin must be sought in the Flagellata or the Mycetozoa rather than in the primitive green algæ; this confirms the conclusion arrived at independently by Nemec (see note in Nature, vol. lxxxix., p. 539).

Miss Annie D. Betts contributes to the current number (December, 1912) of *The Journal of Economic Biology* an extremely interesting account of the fungi of the beehive, having by her investigations added considerably to the knowledge of this subject. The results are based on work done on the combs of stocks which died during the years 1910 to 1912 of the Isle of Wight bee disease. Twelve fungi are described, of which two are apparently confined to beehives, others adapted to hive-life but not confined to this habitat, while others again are commonly or occasionally present but not specially adapted to life in the hive. Some of the fungi belonging to the last category (Penicillium, Aspergillus, and other "moulds") are ubiquitous, but in other cases the fungus spores must be carried from hive to hive by the bees themselves. None of the fungi described appear to be pathogenic, though the presence of much mould in a stock is, if not a cause, at any rate a sign of unhealthy conditions, indicating either that the hive is not weather-proof or that the colony is weak.

The mysterious sounds known under the general name of brontides, but locally as barisâl guns, mistpoeffeurs, &c., have for some months past been very noticeable in the south-west of Haiti. In this island the sound is called the *gouffre*. According to Mr. J. Scherer (Bull. of the Seis. Soc. of America, vol. ii., pp. 230–232), it is most frequently heard in the range of La Selle. On its northern side, this range is bounded by a steep cliff, formed by displacements along a fault that is believed to be still growing. The sounds appear to come from the base of this cliff, and, as they are the same as those which accompany noticeable earthquakes (the Haitians apply the name of *gouffre* to both), it is suggested that they are caused by small adjustments of the crust along the fault. The *gouffre* is also heard in the northwestern part of the island, at Port-de-Paix and Limonade.

In view of the approaching return of the drift-ice season, the meteorological chart of the North Atlantic for February, issued by the Deutsche Seewarte, contains an interesting summary of the prevalence of ice in that ocean during 1912. The Meteorological Office charts also contain much useful information on the same subject, with table showing the extreme limits of icebergs and field ice in 1901–12, and diagram of phenomenal drifts during a long series of years. Last year the drift was one of the most remarkable ever known; little ice was sighted prior to the middle of February, but by the end of March a general and rapid spread was observed. By the end of May the drift reached about $38\frac{1}{2}°$ N., and in June its southern limit had extended almost to 37° N. The positions laid down on the charts refer to the general drift; isolated bergs were met with much further south. In fact, the Meteorological Office diagram shows that ice may be observed almost anywhere in mid-ocean north of 30° N. With reference to the rate at which icebergs may travel, the Seewarte quotes an interesting case. On April 29, in 41° 25′ N., 41° 43′ W., the ss. *Clio* passed a berg supposed to be that with which the *Titanic* collided on April 14, and which therefore had travelled 380 nautical miles, E.$\frac{1}{4}$S., in fifteen days. One end of the berg was broken off, probably owing to impact with a vessel, and the water round about it was strewn with wreckage, such as chairs, towels, and other articles.

In the *Revue générale des Sciences* for January 15 Mr. R. de Baillehache, one of the members of the French Commission on Units, directs attention to the advantages of the metre-kilogramme-second system for practical as well as scientific purposes. In view of the legislation on the subject foreshadowed by the French Minister of Commerce and Industry in August last, he draws up a scheme of definitions and suggests several new names for the units which up to the present have not had special names assigned to them. For the unit of capacity the litre is retained and the cubic metre becomes the kilolitre. The unit of force—the cop (Copernicus)—communicates an acceleration of one metre per second to a mass of one kilogramme. The unit of pressure—the tor (Torricelli)—is one cop per square metre, and is equal to ten baries. The unit of heat is the kilogramme degree of water at 15° C. The electrical units are the present ohm, volt, and ampere.

THE December, 1912, number of *Terrestrial Magnetism* contains an account, by Dr. G. E. Hale, of the attempts which have been made at Mount Wilson Solar Observatory to detect the Zeeman effect due to the magnetic field at the sun's surface. An objective of 1 ft. diameter and 60 ft. focal length forms an image of the sun on the slit of the 75-ft. spectrograph, which to prevent temperature disturbances is mounted in a vertical shaft in the ground. Photographs of the region near the sodium lines in the third order spectrum were taken, and a neat polarising arrangement allowed either the red or the violet edge of a broadened line to be photographed. The plates on measurement showed evidence of a positive displacement of the lines in the northern and a negative in the southern hemisphere of the sun, the magnitudes reaching their maxima at about 50° north or south latitude. Further observations are being made with the view of fixing the magnitudes of the displacements more accurately.

WITH reference to Mr. R. M. Deeley's letter on retinal shadows in NATURE of January 30, we have received other letters bearing upon the point. Mr. H. H. Bemrose thinks, probably correctly, that they are the same as Purkinje's figures. Mr. C. Welborne Piper once saw similar branching lines after experimenting with powerful sources of light. In his case they were coloured red against a background of an approximately complementary colour, whilst with the other eye green vessels were seen against a red background. Purkinje's figures are most easily seen with lateral illumination of the dark-adapted eye. Shadows of the retinal vessels are then thrown upon the sentient layer of the retina, the rods and cones. Mr. Piper's observation is of considerable interest. Black print has frequently been seen to look red when viewed in bright illumination. This is undoubtedly due to coloration of the light by blood during transmission through the lateral wall of the eyeball. Birkhoff, however, has shown that erythropsia or red vision may occur after gazing at a brightly illuminated surface for ten to fifteen minutes when all lateral light is excluded. Rivers holds that erythropsia in general is due to blood, the conditions under which it is observed being such as more or less to eliminate the normal red adaptation of the retina. The transient appearances noticed by our correspondents may be regarded as Purkinje's figures seen in unfavourable circumstances owing to the general diffusion of the illumination.

THE February issue of *The Chemical World* contains a reprint of a hitherto unpublished letter from Sir Humphry Davy to Prof. W. T. Brande, who in 1813 succeeded him as professor of chemistry in the Royal Institution. Written from Idria, it contains a description of a visit to a quicksilver mine containing veins of cinnabar up to a foot in thickness. Davy also records the occurrence, in the great salt mine at Halstadt, of a blue variety of salt; as this blue colour is now attributed to the action of radium emanation, it is not surprising to read the statement: "I have been again searching in vain for the cause of this extraordinary colour." Both mines, occurring in bituminous schist, contained dangerous quantities of inflammable air, and gave to Davy the opportunity of introducing his safety lamp. The letter, with two others, is now in the possession of Sir William Tilden.

SOME interesting views as to osmosis in soils are developed by Dr. C. J. Lynde and Mr. F. W. Bates in two papers published in *The Journal of Physical Chemistry* (vol. xvi., pp. 758–781). Experiments are brought forward to show that a clay soil acts as a semi-permeable membrane, and that by virtue of the osmotic pressure of the solutions of salts in the soil transference of water can be effected. The efficiency of a soil column as a semi-permeable membrane increases with its depth, comparatively long columns being necessary to produce the same effects as a perfect semi-permeable membrance. The view that an osmotic movement of water occurs in soils would explain an increased supply of water brought through the subsoil to the surface in the summer months, when the plants actually need more water. and the beneficial results of soil mulching and certain practices in dry farming.

THE January issue of the Journal of the Chemical Society contains an important paper by Mr. T. R. Merton on the photography of absorption spectra. A method has been adopted which resembles those recently devised by Dr. Houstoun, of Glasgow, the chief feature of which is that the actual "extinction-coefficients" are measured instead of merely the thickness of solution required to blot out a particular spectrum line in a photograph. By using this method it has been found possible to determine the actual form of the extinction-curves, and in particular the shape of the single absorption band in the visible spectrum of cobalt nitrate (Proc. Chem. Soc., January 23, 1913). It appears that the curve showing the width of spectrum absorbed is of a simple mathematical form, its distribution about the central axis of the band being identical with that of the well-known probability curve. The axis of the band is, however, not vertical, *i.e.* the wave-length of maximum absorption changes slightly with the concentration of the solution. It is suggested that the anomalous form of many extinction-curves is due to the superposition of several curves of the above simple form.

RED Book No. 177 of the British Fire Prevention Committee contains a report on a system of extinguishing petrol fires which has given very satisfactory results. The system comprises either a permanent installation, wheeled fire appliances, or small extinguishers, as the case may be, from which certain chemicals are forced, the extinguishing effect being obtained by the combination of two liquids which produce a thick foam which gradually spreads over the surface of the burning petrol, thereby excluding air and extinguishing the fire. According to the report, two petrol fires of considerable area and severity were creditably dealt with, as well as numerous smaller fires, and the extinguishers were also effective on celluloid fires. The system is one which claims the attention of those concerned in the ever-increasing hazards of petrol, used particularly for transport purposes. Copies of the report may be obtained from the assistant secretary, British Fire Prevention Committee, 8 Waterloo Place, S.W.

We have received a copy of an address delivered by Prof. C. Neuberg before the members of the German Zentralstelle für Balneologie, at Schwerin, in September last, entitled "Beziehungen des Lebens zum Licht" (Berlin, Allgemeine Medizinische Verlagsanstalt, pp. 63, price 1.50 marks). This address contains a valuable summary of recent work on the influence of light on living organisms, both from the chemical and biological aspects; in this field Prof. Neuberg has himself been an active worker, and some of the views he develops, regarding the influence of sunlight on health and disease, will be read with considerable interest.

An illustrated article in *Engineering* for February 14 gives an account of the large Humphrey gas pumps installed at Chingford. There are five sets in all; the first two were started on January 18 and 19, and the third a week ago; the remaining sets will no doubt be at work before the official opening of the Chingford Reservoir by his Majesty the King on March 15 next. No accurate tests have been made as yet, but it is already sufficiently obvious that the guaranteed output is being very substantially exceeded. So carefully have the designs of the pumps been worked out that the only detail altered, as the result of seeing them at work, has been the substitution on certain valve-spindles of a solid nut instead of the split one originally provided. It has required considerable courage to accept a contract, under very stringent penalties, for pumps of this type, 7 ft. in diameter, and developing each between 200 and 300 h.p., on the basis of the experience gained of an experimental pump having an output equivalent to about 35 h.p only. The results so far have entirely justified Mr. Humphrey's confidence in the capabilities of his remarkable contribution to the progress of mechanical engineering.

OUR ASTRONOMICAL COLUMN.

Variation of Latitude: the Kimura Term.—After applying all known corrections to the results obtained by the International Latitude Service, there remains a periodic term, known as the Kimura term, for which many explanations have been suggested. Dr. F. E. Ross now suggests that this term is not real, but is due to our lack of knowledge concerning the method of treating the results. He points out that any one of the suggested explanations is efficient, but argues that there is no need for them, for any periodic error in the system of mean declinations adopted would produce a so-called Kimura term. (*Astronomische Nachrichten*, No. 4630.)

Westphal's Comet.—Having investigated, by Pontécoulant's method, the perturbations of Westphal's comet (1852iv) for the period 1852–1914, Herr M. Viljev publishes a set of elements and a number of search-ephemerides in No. 4621 of the *Astronomische Nachrichten*. As the time of perihelion passage is still uncertain, he gives a number of ephemerides, extending to March 12, which cover the period ± 240 days on either side of the computed epoch; the period of the comet is 61·5554 years, and it last passed perihelion on October 12, 1852.

The Opacity of the Atmosphere in 1912.—An article in No. 63 of the *Gazette astronomique* directs attention to the general opacity presented by the sky on cloudless nights during the late spring, the summer, and the autumn of 1912. M. de Roy found sixth-magnitude stars invisible to the naked eye, even on moonless nights and at the zenith, while other observers in many parts of the world found a lack of transparency, noticeable in observations of the sun and stars and in the unusual paleness of the blue of the sky. A suggested explanation of the phenomenon is that volcanic eruptions, more especially the one which took place in the Alaskan peninsula and Aleutian archipelago in June, polluted the atmosphere with fine dust, and so reduced its transparency.

A ZOOLOGICAL GARDEN FOR EDINBURGH.

The council of the Zoological Society of Scotland, in pursuance of its project of raising the necessary funds for the purchase and laying out of the estate of Corstorphine Hill House as a zoological garden and park, as announced in Nature of January 30, has issued a prospectus giving a brief account of the development of the modern zoological garden of the type the society wishes to establish, together with some suggestions regarding the benefits of such an institution to education, science, and art, and a full description of the site selected for the purpose. The prospectus is illustrated with scenes depicting enclosures and ranges in the New York Zoological Park and in Carl Hagenbeck's menagerie at Stellingen, which, with modifications, will serve as models for the kind of accommodation it is proposed to adopt for the animals in Edinburgh. Finally, there are many beautiful views of the grounds of the above-mentioned estate, which not only testify to the wisdom of the council in its choice of a situation, but suggest that, given the necessary funds for the purchase of stock and the upkeep of the collection, Scotland will be able to claim that it has at least the most picturesque zoological garden in Europe.

The scheme for the establishment of the garden was in some danger, at the time of our recent note on the subject, owing to the approaching expiry of the society's option for the purchase of this fine site, and the doubt whether a sufficiently large amount would be subscribed within the brief period remaining. This danger has been averted by the action of the Edinburgh Town Council, which has agreed to purchase the site, of which the society will have the entire use and control in return for an annual payment of 4 per cent. on the price, the society having the right to redeem the site from the corporation within fifteen years. The society is already assured, by gift and loan, of a large and representative collection of animals, and it is the intention of the council to have a number of them installed and the garden open to the public by the beginning of July, 1913, though operations involving much disturbance of the ground will be deferred until the winter months. Funds are urgently needed, both for the future development of the garden and for the redemption of the site, and donations should be intimated to the honorary treasurer, Mr. T. B. Whitson, C.A., 21 Rutland Street, Edinburgh.

NAVIGATION AT THE ROYAL TECHNICAL COLLEGE, GLASGOW.

THE steady diminution in the supply of officers for the mercantile marine, which has been going on for the past few years, is becoming a serious problem to shipowners. The average number of certificates as second mate granted annually by the Board of Trade has fallen from 1132 to 746, or 34 per cent., during the last fifteen years, and as a considerable wastage in the number of candidates takes place during the compulsory period of qualifying sea service between the granting of this initial certificate and that of master, it follows that there is a corresponding reduction in the number of officers qualified to fill the higher ratings on board ship.

The governors of the Royal Technical College, Glasgow, being impressed with the desirability of providing improved facilities for instruction in nautical subjects, established in 1910, with the financial assistance of the City Educational Endowments Board, a School of Navigation.

The instruction offered has been eagerly taken advantage of during the two years' existence of the school, but mostly by students out of their apprenticeship stage. It has, however, been felt all along that a development on the lines of practical as well as theoretical training was necessary. At present parents who send their sons into the mercantile marine deprive them of opportunities of higher education that in universities and technical colleges are offered to youths who enter other professions.

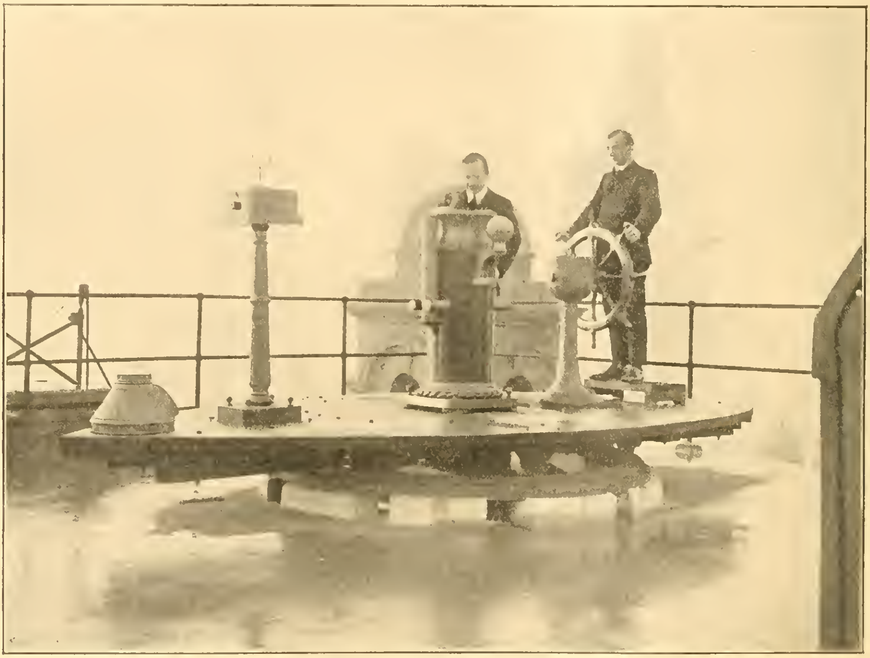

FIG. 1.—Deviascope (Royal Technical College, Glasgow).

This state of affairs has been brought about by the disappearance of the sailing ship and by the reluctance of shipowners to carry apprentices in steamers. It is partly due also to the fact that the requirements for the essential certificates of competency have within recent years been made more exacting, and the subjects increased, so that candidates who would have been capable of passing the old tests find the higher standard now demanded a serious obstacle. Further, the great increase in shipping tonnage has created a large demand for qualified officers, there being only some 30,000 to man our mercantile marine fleet of some 9000 vessels, figures which go to show that the navigator's profession is by no means an overcrowded one.

In order, therefore, to coordinate theory and practice, the governors have arranged to provide a two years' course of training as marine cadets for lads who have just left school and have reached the stage of the Scotch intermediate leaving certificate.

The winter session will be devoted by the cadets to the more theoretical side of their subjects, whilst attending the classes in the college. The summer will be spent afloat on board the seagoing training steamer *Vivid*, a vessel of 550 tons, which has now been acquired from the Admiralty. The ship will be commissioned in April each year, and, having bunker capacity for a steaming radius of 3000 miles, she will be capable of making extended voyages. Dormitory, dressing and bathroom accommodation is being provided for fifty cadets, who, in addition to performing the ordinary routine work of the ship, will be instructed in the duties of the navigator and seaman as required on board a first-class modern ship. Strict discipline is to be maintained on board, and the cadets will be at all times under the supervision and guidance of the instructors. The addition of the *Vivid* to the equipment of the school provides opportunities for the practical testing of the theoretical work of the lecture-room under actual seagoing conditions, and the vessel, in fact, furnishes the laboratory which in every other department of applied science has long been considered an essential adjunct to efficient instruction.

In framing the scheme of instruction, the governors of the college have kept in view the fact that owing to increased competition and the consequent necessity of saving every mile of distance and minute of time, the ingenuity of the shipbuilder, engineer, and man of science has provided the modern navigator with instruments of precision undreamt of in the earlier days of steam navigation—instruments the proper use of which demands a sound knowledge of the principles underlying their construction and a careful training in their manipulation.

The course of training has the support of the leading shipping firms, as it is recognised that the cadets who have gone through the full course will be of immediate value on board ship, instead of, as at present, wasting at least the first year of their apprenticeship picking up the elements of their profession in a haphazard fashion.

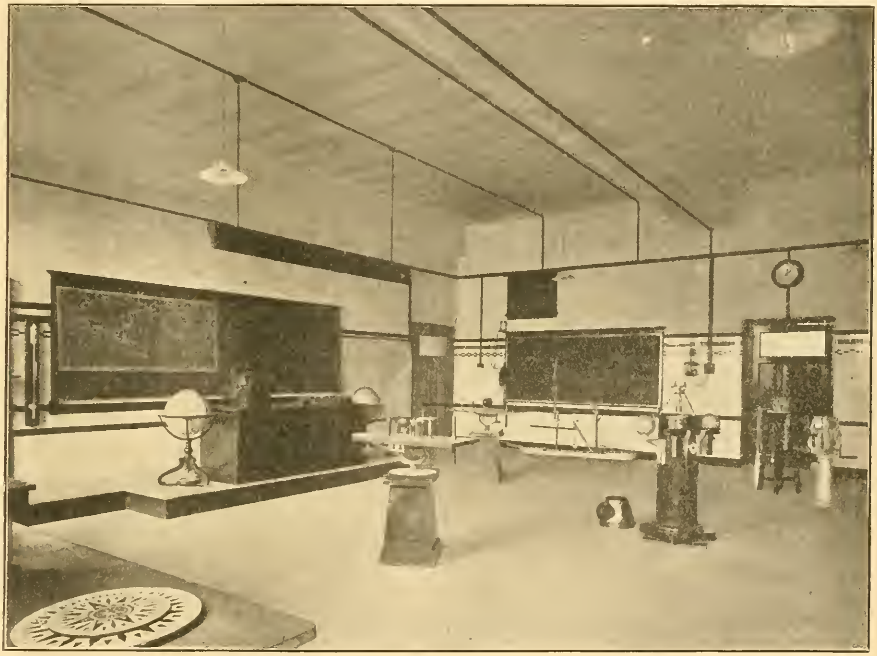

FIG. 2.—Navigation laboratory of the Royal Technical College, Glasgow.

BIOLOGICAL WORK IN INDIA.

ALTHOUGH the mosquito-destroying capacity of the small cyprinoid fishes known to the Spanish inhabitants of Barbadoes as *milliones* appears to have been considerably overestimated, naturalists in India are convinced that many of the smaller fresh-water fishes of that country play an important *rôle* in this respect. Experiments have been carried on for the last few years by officials of the Indian Museum with the view of procuring exact details on the subject, and the result is a report, published by order of the Trustees, on "Indian Fish of Proved Utility as Mosquito-destroyers," drawn up by Capt. R. B. S. Sewell and Mr. B. L. Chandhuri, in which eleven species are scheduled with such descriptions and illustrations as render their identification easy. What, if any, practical results ensue from the investigation remain to be seen.

An issue of the Entomological Series of the Memoirs of the Department of Agriculture (vol. ii., No. 9), forming the second part of life-histories of Indian insects, records the results of investigations carried on at Pusa on the early stages of two species of Rhynchota and eight of Coleoptera. The memoir is illustrated with coloured plates, and, as mentioned in the preface, Mr. D. Nowrogee, to whom the investigation was entrusted, is to be congratulated on the manner in which he has carried out a difficult task.

Beautifully executed illustrations in colour are likewise a feature of a second article on insects injuriously affecting casuarina trees in Madras, by Mr. V. S. Iyer, forming Forest Bulletin No. 11. The worst offender seems to be the caterpillar of the moth *Arbela tetraonis*, but the fat grubs of a longicorn beetle are likewise harmful.

No. 10 of the serial just quoted is devoted to an account, by Mr. R. S. Hole, of the great outbreak of bark-boring beetle-larvæ in the coniferous forests of the Simla district between 1907 and 1911. Five species were involved in this very serious attack.

From among several articles in vol. vii., part ii., of the Records of the Indian Museum, attention may be concentrated on one by Dr. N. Annandale on the Indian fresh-water soft tortoises, or mud-turtles, of the family Trionychidæ. The author recognises one species and two subspecies which were not included by Mr. Boulenger in the volume on reptiles in the "Fauna of British India," namely, Anderson's *Trionyx nigricans*, from Chittagong, which has hitherto been insufficiently described, and two local races of the widely spread *Emyda granosa*. Nor is this all, for Dr. Annandale resuscitates Gray's genus Dogania for *Trionyx subplana*, on the ground that in the upper shell of this species the entire series of costal plates is separated by mural bones, instead of the last pair meeting in the middle line.

In Records of the Indian Museum, vol. vii., part iii., Mr. J. R. Henderson describes a new tortoise from the Cochin district of southern India, under the name of *Geoëmyda sylvatica*, Geoëmyda being used as equivalent to Nicoria.

Eri or endi silk, the product of the caterpillar of a large Assamese moth, of which the technical name does not appear to be mentioned, forms the subject of the first number of vol. iv. of the Entomological Series of the Memoirs of the Department of Agriculture of India. According to the authors, Messrs. H. Maxwell-Lefroy and C. C. Ghosh, this silk, which from its nature cannot be reeled, is spun and woven in Assam into an exceedingly durable cloth, which readily takes vegetable dyes. Experiments have been undertaken at Pusa with the view of ascertaining whether the cultivation cannot be extended to other parts of India, with results that appear promising. As the cocoons are not damaged by the moths in making their exit, there is no necessity for killing the latter, which renders the silk acceptable to sects like the Jains, who object to taking life in any circumstances.

R. L.

MAGNETIC PROPERTIES OF ALLOYS.

Vol. VIII., parts 1 and 2, of the Transactions of the Faraday Society contain a series of papers which were read at a special meeting of the society held for the general discussion of the magnetic properties of alloys. The papers naturally fall into two groups, viz. those dealing with ferrous and with non-ferrous alloys respectively.

The iron-carbon and iron-silicon alloys form the subject of an exhaustive paper by Dr. Gumlich, which is of considerable importance in connection with transformer working. He finds that the presence of large amounts of silicon result in the metal, even when quickly cooled, exhibiting a pearlitic structure rather than containing the injurious solid solution of carbon in iron. With prolonged annealing even the pearlite is decomposed into ferrite and temper-carbon. A silicon content of 3 to 4 per cent. is necessary for this effect, so that the good magnetic properties of thin sheet-metal containing less than this amount of silicon must have another origin. Figs. 1 and 2 show an alloy with 4·5 per cent. silicon and 0·29 per cent. carbon. Fig. 1 is with the metal in the untreated condition, and Fig. 2 after annealing at 975° C. The annealing has resulted in the pearlitic structure giving place to enclosures of temper-carbon, and the coercive force has been reduced from 1·26 to 0·65 C.G.S. units. A paper by Messrs. Colvert-Glauert and Hilpert, on the magnetic properties of nickel steels, describes a series of tests the results of which are at variance with the view that the peculiar magnetic properties of these alloys are due to the nickel retarding the

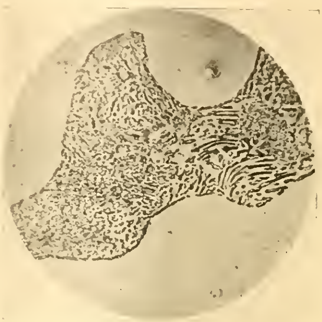

Fig. 1.—4·5 per cent. silicon-iron alloy (untreated).

change from γ-iron to α-iron. They find all their nickel-iron alloys when quenched at 1200° C. to be strongly magnetic, and they have come to the conclusion that at that high temperature a strongly magnetic compound is formed which persists through all subsequent thermal treatments.

Prof. Wedekind's paper on the magnetic properties of compounds in relation to their stoichiometric composition summarises very clearly the present state of

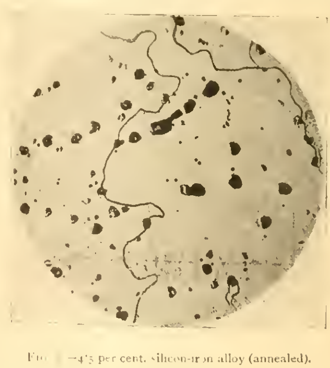

Fig. 2.—4·5 per cent. silicon-iron alloy (annealed).

knowledge on this important subject. It is found that simple compounds of ferromagnetic metals are throughout essentially more feebly magnetic than are the metals themselves, so far as they represent one particular degree of valency. Simple compounds of the latent-magnetic metals (manganese, chromium, vanadium, and (?) titanium) are generally more strongly magnetic than the metals, and some of the compounds exhibit residual magnetism. The maximum magnetisation is determined by the stoichiometric composition, especially where several compounds of the same components exist. Manganese, for example, has a maximum in the trivalent condition with such elements as can themselves be trivalent.

Several papers deal with the Heusler alloys. Dr. Ross describes a series of magnetic investigations from which it is concluded that the magnetism of these alloys is associated with the occurrence of solid solutions having the intermetallic compound Cu_3Al as one constituent, and probably Mn_3Al as the other. The theory is supported by evidence gathered from examination of the microstructure and from cooling curves. Drs. Knowlton and Clifford, in their paper, also appear to favour the hypothesis of a series of solid solutions as best suiting their magnetic results, but Drs. Heusler and Take still adhere to their belief in a series of ternary magnetic compounds of the general formula $Cu_xMn_yAl_z$, where x and y can have any of the values 1, 2, . . ., and $x+y=3z$. It seems now to be certain that these Heusler alloys—despite their very small hysteresis loss under certain conditions of thermal treatment, &c.—do not give promise of practical applications in electrical measuring instruments. Their extreme variability, their hardness, and their brittleness are strongly against all commercial applications.

THE ASSOCIATION OF TECHNICAL INSTITUTIONS.

THE twentieth annual general meeting of the association was held in Birmingham on January 31, when Mr. J. H. Reynolds, of Manchester, the new president, delivered his presidential address, in the course of which he discussed the progress of elementary education since the Act of 1870, and contrasted the abundant provision of the present day with the meagreness which prevailed anterior to the Act. He detailed the causes which operated to prevent the realisation of the full fruits of the great Imperial and local expenditure incurred in the establishment and maintenance of elementary education with special reference to the early age of leaving school, and to the absence of proper measures for securing the continued attendance of the children upon suitably designed courses of instruction and training in evening schools during the years of adolescence. He urged the abolition of half-time and the extension of the school age until fourteen, unconditionally throughout the urban and rural areas of the kingdom, and discussed the demand made that the curriculum of the elementary school should be confined to "the three R's," maintaining that there should be made the fullest possible provision for the education and training of the worker's child for his future life as a producer and as a citizen. He further directed attention to the poor physical condition of many thousands of children in the public elementary schools, and appealed for smaller classes and better trained teachers. He dwelt upon the importance of this question of elementary education, since until it is well considered and effectually provided, secondary education cannot be adequately established, and any technical education and training of real value directly concerned with a livelihood and based upon scientific principles are impossible.

Education is one, and indivisible, and if there is to be a satisfactory superstructure the foundations must be carefully laid, and the whole scheme made organically complete from the elementary school to the university.

Out of a child population between the ages of thirteen and seventeen amounting to upwards of 1,800,000, there were only 325,117 enrolled in evening schools. Measures should be enacted requiring all employers to give facilities for the continued education of their employees between the ages of fourteen and seventeen; until that age was reached the child should remain the ward of the schoolmaster.

The Act of 1902 unified under one responsible authority all forms of education, and for the first time in the history of English education gave the means for the provision of a properly organised system of secondary education. The operations of the Technical Instruction Act of 1889 had awakened a new and serious interest in education, derived from the fact that the ill-prepared educational condition of the students made it impossible to impart successfully any satisfactory training in science or technology.

Under the provisions of the Education Act of 1902 numerous old endowed schools all over the country which had become effete for want of effective public control, and of the means to meet the demands of modern requirements, have been revivified, and large numbers of new secondary schools, well staffed and equipped, have been provided. The great drawback to their efficiency is to be found in the short school life, extending to not more than two years and nine months, contrasting unfavourably with the school life of the German gymnasium and the *Ober-Real-Schule*, extending to nine years, and ending in a leaving examination, admitting without further test to any technical high school or university in Germany. Measures should be taken to ensure a satisfactory length of school life in English secondary schools, concluding with a school-leaving examination giving admission at once to any institution for higher learning.

We have further so to systematise our secondary education that in going from one large urban or other centre to another the scholar will be sure to find a school of similar standing to that he has left. It is to the improvement of the product of the elementary school and in the extension of the school age until fourteen, to a large increase in the number of secondary schools and in the extension of the length of the school life therein, so as to approximate to that of the German and Swiss secondary schools, that we must look for the future growth and efficiency of technical institutions.

Having regard to English conditions these institutions have done an immense service in the past in providing the means of continued education and training for the great mass of the youths engaged in our trades and industries, and English manufacturing industry owes much of its pre-eminence, especially the engineering industries, to the work and influence of these evening schools. In this connection the work of the Department of Science and Art and of the City and Guilds of London Institute has been of high importance and value.

The opportunity of further instruction and training of this character in day classes is much to be desired.

It is satisfactory to note that many of the more important firms, especially in the engineering and chemical industries, are encouraging the admission of a much better type of educated and trained man into their works, and are offering facilities and inducements based on training age and attainments. As industries grow in respect of the number and varied equipment of the men employed, and in the extent and complexity of the production, a higher type of man is required, characterised by a better general education, more expert knowledge and practical ability. It is realised that "the day of the trained man has come; that of the untrained man is past."

A new science has come into being, namely "the science of industrial management," demanding special qualities and the amplest training, the aim being to secure "a large increase in the wage-earning capacity of the workman," and "a still larger decrease in the labour cost of his product." But not only is it necessary to consider the efficiency of the workman as such, but thought must be given to his life as a citizen; in short, not only economic but ethical considerations must have place, since industry demands the humanising influence of the most cultivated intelligence to ensure its complete success. In the words of Prof. Smithells: "Professions and business vocations are more and more becoming learned callings, each developing a special body of knowledge, which requires for its full mastery and effective use an intellectual training of what may be called the university standard."

The demand for this in respect of the great engineering and chemical industries has long been recognised and met in Germany. Hence the importance given to chemical and physical science, and the lavish provision made for its teaching in nearly all her great universities, and to engineering in her technical high schools, of which, if the Polytechnikum at Zurich be included, there are now twelve with upwards of 13,000 day students taking full four-year courses, nearly all of them as a condition of entrance demanding from engineering students at least one year's experience in a works, and no admission except to duly accredited students from a gymnasium or school of equal standing. These schools are all—*vide* Dr. Nicolson's recent report—largely increasing their engineering equipment, so as to bring it up to the latest advance in engineering science and equipment, and with a view to further investigation and experiment in the service of the industries. Having regard to this equipment, to the spirit of investigation and research, and to the large body of highly educated students, we cannot be surprised at the position Germany now takes in the world of applied chemistry and engineering.

It is further stated upon high authority that the exceptional expenditure on new plant and buildings at eight German technical high schools, including that of Zurich, during the last five years has been 785,000*l*. If Englishmen mean to maintain their great industrial position they must follow in the steps of Germany, since in many important spheres of engineering practice she even now takes the lead. It would be an interesting inquiry, perhaps somewhat disquieting in its results, to learn how many German patents are at this moment being worked in this country under licence.

During the last few years there has been a definite movement on the part of certain of our large technical institutions towards a closer connection with the universities within their own area, of which there are now thirteen in England and Wales, compared with three teaching and self-examining universities prior to 1880, marking an immense progress in the organisation of higher education within a generation. Of such institutions may be named Manchester, Bristol, Glasgow, Edinburgh, Belfast, and certain of the London technical institutions. Students in each of these institutions fulfilling the required conditions are now eligible for the degrees of their respective local universities to which they are attached. It is to be observed also that the ancient universities of Oxford and Cambridge have now strong technological departments, which help to put English institutions, though still far behind as a whole, in a much more favourable light than would at first appear on a comparison with Germany.

In this connection it is convenient to note the wisdom and liberality of the policy of the Royal Commissioners for the Exhibition of 1851, whose scheme of science scholarships has been so fruitful in result, in the establishment in 1911 of the scheme of industrial bursaries to enable graduates of certain defined institutions to enter upon industrial work at the close of their ordinary university course, thus enabling those men whose qualifications fitted them well to take part in the application of science in the industries, but who were often diverted to less suitable employment by the necessity of earning a livelihood, to be relieved from constraint in their choice of occupation, and to enter into positions more suitable to their training and abilities. Eighteen bursaries were awarded, the payments ranging from 35*l*. to 100*l*. per annum, varying according to salary and circumstances.

It is gratifying to note the great progress which has been achieved in scientific and technical education during even the last twenty years, the more sympathetic attitude of employers in the important industries, the increased liberal support, still far from the amount the circumstances demand, of the Imperial Government, and generally the growing appreciation by the public of the value and necessity of the best possible education in due degree for all the children of the nation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—At the annual meeting of the Court of Governors, Prof. G. Barling was elected Vice-Chancellor of the University to fill the vacancy caused by the death of Alderman C. G. Beale. It is understood that in consequence of his election to this position, Prof. Barling will resign the chair of surgery, which he has held since the foundation of the University. He recently resigned his post of dean of the faculty of medicine, which he had held for six years, being succeeded by Prof. Peter Thompson.

The council, having received an offer from the Board of Agriculture of a grant-in-aid, to be expended in carrying on a research department in agricultural zoology, has appointed Prof. F. W. Gamble, F.R.S., as director of the new department. An assistant director is to be appointed, who will devote his whole time to the duties, under the supervision of Prof. Gamble. It is understood that the department will specialise in helminthology.

CAMBRIDGE.—Prof. H. F. Newall has conveyed to the Vice-Chancellor, on behalf of a donor who desires to be anonymous, an offer to the University of an endowment for the professorship of astrophysics. In the course of his letter, Prof. Newall remarks: "The transfer of the Solar Physics Observatory to Cambridge introduces into the University a new study. The fresh opportunities and obligations which it opens up can better be met by fresh endowments sufficient to secure permanently the services of a professor of astrophysics (who would also be responsible for solar physics) than by any measure that involves the diversion of the services of the Plumian professor from the development of dynamical astronomy and from the training of men in that department of knowledge. If such a permanent professorship of astrophysics be established, it is desirable that its emoluments should be sufficient to attract really able men, and to raise it to a high rank among university posts." This statement of the position of the subject was placed before the anonymous benefactor, who has empowered Prof. Newall to convey the following offer to the Vice-Chancellor:—"Should the University concur in the views you have expressed to me, I am prepared on the occurrence of the first vacancy in the chair of astrophysics to contribute a sum of ten thousand pounds towards the permanent endowment of the chair, provided that the University is willing to undertake to supplement this sum by such further endowment either of principal or of income as will raise the emoluments of the chair thenceforward to 800*l*. a year."

Mr. C. Hankins, forester to Earl Cadogan, has been appointed adviser in forestry. He will be under the supervision of the reader in forestry, under whose responsibility all working plans and proposals of a general nature will be issued.

OXFORD.—The proposal to allocate a site in the University Park for the erection of an engineering laboratory has been dropped, it being understood that a suitable piece of ground will be available for this purpose without encroaching on the open space which adds so greatly to the amenities of Oxford.

MR. W. JAMES THOMAS, of Ynyshir, has increased his gift of 10,000 guineas to the University College of South Wales and Monmouthshire to 12,750*l*. in order to cover the full cost of erecting a medical school.

A LEADING article in *The Chemical World* on the Oxford University Laboratory directs attention to the remarkable developments that are in progress in the teaching of chemistry in the Universities of Oxford and Cambridge. Since the institution of the new *régime* at Cambridge, four years ago, 150 original communications have been published from the chemical laboratory of that University, a record that is probably unequalled by any laboratory in this country or elsewhere. In the same period the number of graduate and post-graduate students in the laboratories has more than doubled. There can be little doubt that similar developments are to be anticipated at Oxford, following the recent election of Prof. W. H. Perkin to the chair of chemistry.

THE governing body of the University of Wisconsin has decided, says *Science*, to ask the State legislature, now in session, for 200,000*l*., to be granted in sums of 50,000*l*. a year for four years, in order to provide and equip further accommodation for men students. The continuance of the present appropriation of 60,000*l*. a year for the construction and equipping of academic buildings will also be requested. For the further development of university extension work, an increase of 5000*l*. a year is desired. Owing to the reduction in the assessed valuation of personal property, resulting from the adoption of the income tax in Wisconsin, the University's fund for current expenses has this year fallen below the amount anticipated. The governors, therefore, have requested that the sum of 18,500*l*. be appropriated to make up this year's decrease, that 35,000*l*. be provided for next year's decrease, and 45,000*l*. for the following year's decrease.

VERY important developments are now taking place in the Royal (Dick) Veterinary College in Edinburgh. Not the least important is the removal from the present limited quarters to what will in a year or two be a fine addition to the many colleges which adorn the city. To make room for the new buildings, some quaint cottages of a bygone epoch will have to be removed. These are in what is known as Summerhall Square, which lies to the east of the East Meadows in the southern part of Edinburgh. The main frontage of the buildings will face west, and in the rear the clinical department will be housed in buildings quite distinct from those devoted to teaching and administration. The various laboratories and class-rooms will be equipped with the best modern appliances for the study of the diseases and treatment of domestic animals. Another important development is the establishment of a degree in veterinary science in the University of Edinburgh. The regulations require the student to attend certain of the more purely scientific courses in the University, but the more technical part of the training is given in the Royal Veterinary College. Though no nearer to the University than the present college building, the new buildings will be much more conveniently situated, and the practical affiliation of the two institutions will be more thoroughly effected. It is expected that the new college will be ready for use in October, 1914.

ON February 13 a brilliant University function was held in the Library Hall of Edinburgh University, when Sir William Turner's portrait was presented by the subscribers to the University. Mr. A. J. Balfour, M.P., the Chancellor of the University, presided, and received the portrait from Sir Robert Findlay, M.P., who presented it in the name of the many subscribers. Sir Robert Findlay, himself an old pupil of Sir William's, spoke of the sixty years' service which Sir William had rendered to the University, first as assistant to Prof. Goodsir, then as professor of anatomy, and finally as principal of the University. As Sir Robert made the presentation, the curtain was drawn aside and revealed a striking and happy portraiture of the veteran principal, by the hand of Sir James Guthrie, president of the Royal Scottish Academy. Mr. Balfour, in his remarks, dwelt on the remarkable developments which had taken place during the last fifty years in university life in Edinburgh. In making their University keep up with modern needs, Sir William Turner was the man who above all others had taken the greatest share in this development. He combined in an unusual way the qualities of a great teacher and a great administrator. Lord Provost Inches having expressed the high appreciation which the Corporation had for Sir William, whom a few years since they had enrolled as a burgess of their city, Sir William Turner, after thanking his many friends and old students for their great kindness, gave some interesting reminiscences of the early days in which he began his life in Edinburgh. Although he could not claim Edinburgh as his birthplace, he was sure no one could love the old city better than he did, or could have a higher regard for its historic associations and its peculiar and indefinable charm. The ceremony they had been engaged in would remain in his mind, during the brief period that he might look to for a continuance of life, as a mark of confidence and esteem from his colleagues, students, and friends.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 13.—Sir Archibald Geikie, K.C.B., president, in the chair.—Prof. R. A. **Sampson**: A Cassegrain reflector with corrected field. The purpose of this memoir is to discover an appliance which shall correct in a practical manner the faults of the field of a Cassegrain telescope while leaving unimpaired its characteristic features of great focal length, convenient position of the observer and achromatism. It is shown in agreement with the investigation of Schwarzschild that two mirrors alone cannot correct the field without introducing impracticable curves or sacrificing the general design. A system of lenses is investigated which shall effect the purpose. Three lenses is the least number which can satisfy the two conditions of achromatism.

Achromatism for all colours is preserved completely by making all the lenses of the same glass. The first of these lenses is a meniscus silvered at the back, and besides adjusting the achromatism of the other two, serves to reverse the direction of the ray. The other two form a pair of nearly equal but opposite focal lengths and intercept the outcoming beam. By a proper distribution of curvatures between their faces they introduce correcting aberrations. The resulting field is completely corrected for colour, spherical aberration, coma, and curvature of the field.—Prof. H. E. **Armstrong** and Dr. J. V. **Eyre**: Studies of the processes operative in solutions. XXV., The influence of non-electrolytes on solubility. The nature of the processes of dissolution and precipitation.—E. E. **Walker**: Studies of the processes operative in solutions. XXVI., The disturbance of the equilibrium in solutions of fructose by salts and by non-electrolytes. —J. **Chadwick** and A. S. **Russell**: The excitation of γ rays by the α rays of ionium and radiothorium. The work on the excitation of γ rays by α rays, shown first by Chadwick in the case of the α rays of radium C, has been extended to ionium. A preparation of ionium and thorium equal in α-ray activity to 3 mgr. of radium, after purification from all radio-active bodies which emit β and γ rays, was found to emit a small but easily detectable amount of γ radiation. This radiation is shown to be excited by the α rays, either in the ionium itself, or in the thorium with which it is mixed. It s a mixture of three types of radiation differing widely in penetrating power.—Prof. W. E. **Dalby**: Load-extension diagrams taken with the optical load-extension indicator. In this paper further experiments with the indicator are described. The optical load-extension indicator itself was fully described and illustrated in a paper read on March 7, 1912. Load-extension diagrams obtained from phosphor-bronze, gun-metal, and brass are shown, together with photomicrographs taken from the specimens tested. The chemical analyses of the metals are given in each case. The effect of annealing brass rod is brought out by comparing the load-extension diagrams of an annealed and an unannealed specimen and by making a similar comparison of the corresponding photomicrographs of the structure of the material. The physical effect of annealing is to produce a state in which the load-extension curve approaches the shape given by copper, and bears little resemblance to the curve obtained from the same material in an unannealed state.

Zoological Society, February 4.—Sir John Rose Bradford, K.C.M.G., F.R.S., vice-president, in the chair. —Dr. F. E. **Beddard**: The anatomy and systematic arrangement of the Cestoidea. The paper dealt with a number of new species of Ichthyotænia and Ophidotænia obtained from the gut of serpents that had died in the gardens.—H. G. **Plimmer**: Report on the deaths which occurred in the society's gardens during the past year, together with a list of the blood parasites found during the same period. An examination had been made of the blood of every animal that had died, with the result that parasites had been discovered in 140 cases, and in eighty of these for the first time. H. L. **Hawkins**: The anterior ambulacrum of *Echinocardium cordatum* and the origin of compound plates in the Echinoidea. A new method was described of exposing sutures in recent Echinoids suitable for photographic purposes, the process combining staining with etching, and the description of the complex plating of ambulacrum III. in *E. cordatum*. The origin of ambulacrum "plate-crushing," founded on a brief survey of the phenomenon in all groups of Echinoids, was discussed. Mechanical growth-pressure was regarded as the cause, with the growth of tubercles (Lambert's hypothesis) as a secondary and merely modifying agent.—G. P. **Farran**: Plankton from Christmas Island, Indian Ocean. II., Copepoda of the genera Oithona and Paroithona. This collection, made in 1908 by Sir John Murray and Dr. C. W. Andrews, contained eleven species of Oithona and one of Paroithona, or rather more than half the known species, the total number of known species of Oithona being eighteen and of Paroithona two. This indicated the great richness in species of collections made in tropical waters. Seven of the species of Oithona and the one Paroithona appeared to be new to science.

Linnean Society, February 6.—Prof. E. B. Poulton, F.R.S., president, in the chair.—A. W. **Sutton**: Results of crosses between a wild pea from Palestine, presumably *Pisum humile*, Boiss and Noé, and cultivated forms.—Miss **Bancroft**: The structure of *Rhexoxylon africanum*. A fossil stem described by Dr. A. W. Rogers as probably coming from the Karroo rocks of Cape Colony, indicates affinities with the Medulloseæ of later Palæozoic age.—Dr. R. **Verity**: Revision of the Linnean types of Palæarctic Rhopaloc ra.

Mathematical Society, February 13.—Prof. A. E. H. Love, president, in the chair.—T. C. **Lewis**: Figures in n-dimensional space analogous to orthocentric tetrahedra.—J. E. **Littlewood**: A property of the ζ-function. —G. H. **Hardy**: The summability of a Fourier's series. —G. H. **Hardy** and J. E. **Littlewood**: Trigonometrical series which converge nowhere or almost nowhere.—H. **Bohr**: A theorem concerning power series.—P. J. **Heawood**: A graphical demonstration of the fundamental properties of quadratic residues.—J. B. **Holt**: The irreducibility of Legendre's polynomials (third paper).—W. H. **Young**: The mode of oscillation of a Fourier series and its allied series.—H. T. H. **Piaggio**: Some non-primary perpetuant syzygies of the second kind.

MANCHESTER.

Literary and Philosophical Society, February 4. Prof. F. E. Weiss, president, in the chair.—D. **Thoday**: A capillary eudiometric apparatus for analysing small volumes of air. Results of experiments relating to the exchange of gases between plants and the atmosphere. W. B. **Brierley**: The structure and life-history of *Sphaeria lemaneae*. The author traced the origin and development of the vegetative and reproductive organs of *Sphaeria lemaneae*, a fungus inhabiting sexual filaments of Lemanea. The relations obtaining between the host and parasite were elucidated, and the morphological structure and cytology of the fungus shown to be in general agreement with previous knowledge of Pyrenomycetous fungi. The accepted systematic position of *Sphaeria lemaneae* was questioned.

PARIS.

Academy of Sciences, February 10.—M. F. Guyon in the chair.—Pierre **Duhem**: Two fundamental inequalities of thermodynamics. Paul **Sabatier** and M. **Murat**: The direct addition of hydrogen to the phenylacetic esters: the preparation of *cyclo*hexylacetic acid. This reaction requires a large excess of hydrogen in presence of a very active nickel, maintained at 180° C. The yield is quantitative, no loss occurring through secondary reactions. The properties of *cyclo*hexylacetic acid and of five of its esters are described. Charles **Depéret**: Observations on the Pliocene and Quaternary geological history of the gulf and isthmus of Corinth.—Hugo de **Vries** was elected a correspondant of the academy in the section of botany, in the place of M. Schwendener, elected foreign associate. Mlle. S. **Tillinger**: The determination of the growth of functions defined by a Taylor's series.—J. Le **Roux**: The determination of the harmonic functions.—Th. De **Donder**: A theorem of Jacobi.—Henri **Villat**: The determination of problems of hydrodynamics relating to the resistance of fluids.—M. **Gernez**: Construction and use of maps for orthodromic navigation on planes tangent to the poles.—L. **Crussard**: The deformation of waves in gases and on finite interferences.—Carl **Störmer**: An important problem in cosmical physics.—Albert **Turpain**: Recording the Hertzian time signals. The possibility of recording directly and determining to a hundredth of a second the Eiffel Tower time signals. A description of the results obtained by a photographic recorder, by means of which the beats of a chronometer and the wireless time signals are registered on the same sheet.—Edm. van **Aubel**: The latent heat of vaporisation of metals. Utilising the experimental data of Wehnelt and Musceleanu for the latent heats of vaporisation of mercury, cadmium, zinc, and bismuth, Trouton's law is shown to hold for these metals, the constant varying only between 19·36 and 20·2.—A. **Guillet** and M. **Aubert**: Electric losses in the system plane-sphere-atmospheric air. The coefficient of asymmetry and its measurement.—V. **Crémieu**: A new idiostatic voltmeter. The voltmeter is claimed to be very sensitive, not damaged by excessive voltages, and not so fragile as the gold-leaf electroscope.—Jean **Becquerel**, **L. Matout**, and Mlle. W. **Wright**: Hall's phenomenon in antimony. The Hall effect for antimony increases as the temperature of the metal is lowered, and depends on the position of the axes of the crystal in the magnetic field. The electromotive force is not always proportional to the strength of the magnetic field.—William **Duane** and Otto **Scheuer**: The decomposition of water by the α rays. At $-183°$ C. the hydrogen and oxygen evolved are in molecular proportion; in the liquid state the hydrogen is in excess, some hydrogen peroxide being also formed. When steam is decomposed by the α rays hydrogen is also in excess.—Daniel **Berthelot** and Henry **Gaudechon**: The inversion of saccharose by the ultra-violet rays. A criticism of recent work by other workers in this subject.—Marcel **Godchot** and Félix **Taboury**: The catalytic hydrogenation of camphorone; some new *cyclo*pentane hydrocarbons. Camphorone, treated with hydrogen and reduced nickel at 130° C., gives quantitatively dihydrocamphorone. At 280° C. the product is methyl-1-*iso*-propyl-3-*cyclo*pentane.—A. **Duffour**: An interesting case of dimorphism. Benzylvanillic alcohol crystallises in monoclinic or triclinic crystals, according to its method of preparation. The triclinic modification is stable at the melting point.—Robert **Mirande**: The presence of callose in the membrane of some marine Algæ.—C. M. **Bret**: The existence in western Africa of two stable forms of *Hevea brasiliensis* presenting a different aptitude in the production of latex. The two forms can be distinguished by the anatomical study of the base of the petiolules, the most vigorous plant being the poorest in latex.—H. **Bierry** and Mlle. Lucie **Fandard**: Adrenaline and glycæmia. The mechanism which governs hyperglycæmia and glycosuria is not so simple as has been hitherto supposed. Part of the free sugar in excess in the blood can go more or less rapidly into combination without being lost to the organism, the surplus only passing into the urine.—R. **Anthony** and L. **Gain**: The development of the skeleton of the posterior extremity of the penguin.—Armand **Dehorne**: New researches on maturation mitosis in *Sabellaria spinulosa*.—André **Mayer** and Georges **Schaeffer**: The composition of the tissues in non-volatile fatty acids and in cholesterol and the possible existence of a "lipocytic constant." Em. **Bourquelot**, H. **Hérissey**, and M. **Bridel**: The biological synthesis of the glucosides of alcohols (α-glucosides) with the aid of α-glucosidase. The destruction of the α-glucosidase in strongly alcoholic medium. Fernand **Meunier**: The frequent asymmetry of the elytra in Blattidæ of the Coal Measures of Commentry (Allier), and the phylogeny of the groups.—Jules **Welsch**: The primary dunes of Gascony, and an explanation of their formation.

BOOKS RECEIVED.

Vergleichende Physiologie wirbelloser Tiere. By Prof. H. Jordan. Erster Band. Pp. xxii+738. (Jena: G. Fischer.) 24 marks.

One Hundred Simple and Exact Mathematical Proofs that the Valencies of Carbon are Unequal. By H. Collins. Pp. 109. (London: Morton and Burt, Ltd.)

Les Atomes. By Prof. J. Perrin. Pp. xvi+296. (Paris: F. Alcan.) 3.50 francs.

The Observer's Handbook for 1913. Pp. 72. (Toronto: Royal Astronomical Society of Canada.)

Annuario Publicado pelo Observatorio Nacional do Rio de Janeiro. Para o Anno de 1913. Anno xxix. Pp. vii+349+plate. (Rio de Janeiro.)

The Honey-Star. By T. Edwardes. Pp. viii+344. (London: Hutchinson and Co.) 6*s.*

The Bradshaw Lecture on the Biology of Tumours. by Dr. C. M. Moullin. Pp. 39. (London: H. K. Lewis.) 2*s.* net.

Our Vanishing Wild Life: its Extermination and Preservation. By Dr. W. T. Hornaday. Pp. xv+411. (New York: Charles Scribner's Sons.) 1.50 dollars.

Trees in Winter: their Study, Planting, Care, and Identification. By Drs. A. F. Blakeslee and C. D. Jarvis. Pp. 446. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 8*s.* 6*d.* net.

"Red Books" of the British Fire Prevention Committee. No. 176, Fire Tests with Celluloid Substitutes. The Committee's Report. Pp. 31. (London: British Fire Prevention Committee.)

The Fate of Empires: being an Inquiry into the Stability of Civilisation. By Dr. A. J. Hubbard. Pp. xx+220. (London: Longmans and Co.) 6*s.* 6*d.* net.

Luftelektrizität. By Dr. K. Kähler. Pp. 151. (Berlin and Leipzig: G. J. Goschen.) 90 pfennigs.

Health through Diet. By K. G. Haig, with the advice and assistance of Dr. A. Haig. Pp. x+227. (London: Methuen and Co., Ltd.) 3*s.* 6*d.* net.

Diptera Danica: Genera and Species of Flies hitherto Found in Denmark. By W. Lundbeck. Part iv., Dolichopodidæ. Pp. 415. (Copenhagen: G. E. C. Gad; London: W. Wesley and Son.)

Das Wissen der Gegenwart in Mathematik und Naturwissenschaft. By E. Picard. German translation by F. and L. Lindemann. Pp. iv+292. (Leipzig and Berlin: B. G. Teubner.) 6 marks.

British Birds' Nests: How, Where, and When to Find and Identify Them. By R. Kearton. Revised and enlarged edition. Pp. xii+520+plates. (London: Cassell and Co., Ltd.) 14*s.* net.

The Cambridge Manuals of Science and Literature: The Physical Basis of Music. By Dr. A. Wood. Pp. 163. The Story of a Loaf of Bread. By Prof. T. B. Wood. Pp. vi+140. The Modern Warship. By E. L. Attwood. Pp. 146. The Earth: its Shape, Size, Weight, and Spin. By Prof. J. H. Poynting. Pp. 141. The Atmosphere. By A. J. Berry. Pp. 146. (Cambridge University Press.) Each 1*s.* net.

Handwörterbuch der Naturwissenschaften. By E. Korschelt and others. Lief 35–37. (Jena: G. Fischer.) 2.50 marks each Lief.

La Théorie du Rayonnement et les Quanta. Rapports et Discussions de la Réunion tenue à Bruxelles, du 30 Octobre au 3 Novembre, 1911, sous les auspices de M. E. Solvay. Publiés par P. Langevin and M. de Broglie. Pp. iii+461. (Paris: Gauthier-Villars.) 15 francs.

Meddelanden från Statens Skogsförsöksanstalt. Häftet 9, 1912. Pp. iii+260+xxxviii. (Stockholm: Centraltryckeriet.) 2.25 kronor.

Iron and Steel. By O. F. Hudson. With a section on Corrosion by Dr. G. D. Bengough. Pp. x+173. (London: Constable and Co., Ltd.) 6s. net.

Catalogue of the Lepidoptera Phalænæ in the British Museum. Vol. xii., Catalogue of the Noctuidæ in the Collection of the British Museum. By Sir G. F. Hampson. Pp. xiii+626. (London: Longmans and Co., and others.) 17s. 6d.

Dent's Practical Notebooks of Regional Geography. By Dr. H. Piggott and R. J. Finch. Book i., The Americas. Pp. 64. (London: J. M. Dent and Sons, Ltd.) 6d. net.

Memoirs of the Department of Agriculture in India. Bacteriological Series. Vol. i., No. 1, November. Studies in Bacteriological Analysis of Indian Soils. No. 1, 1910–11. By C. M. Hutchinson. Pp. 65. (Calcutta: Thacker, Spink and Co.; London: Thacker and Co.) 2.8 rupees.

Memoirs of the Geological Survey. England and Wales. Records of London Wells. By G. Barrow and L. J. Wills. Pp. iv+215+iii plates. (London: H.M.S.O.; E. Stanford, Ltd.) 4s. 6d.

Le Celluloïd et ses Succédanés. By W. Main. Pp. 163. (Paris: Gauthier-Villars.) 2.50 francs.

Leitfaden der Deszendenztheorie. By Dr. L. Plate. Pp. 55. (Jena: G. Fischer.) 1.60 marks.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 20.

ROYAL SOCIETY, at 4.30.—Studies on Enzyme Action. XIX. Urease, a Selective Enzyme. II. Observations on Accelerative and Inhibitive Agents: Prof. H. E. Armstrong, M. S. Benjamin, and E. Horton.—Nervous Rhythm arising from Rivalry of Antagonistic Reflexes; Reflex Stepping as Outcome of Double Reciprocal Innervation: Prof. C. S. Sherrington.—The Liberation of Ions and the Oxygen Tension of Tissues during Activity (Preliminary Communication): Dr. H. E. Roaf.—Contributions to the Biochemistry of Growth. The Glycogen Content of the Liver of Rats Bearing Malignant Growths: W. Cramer and J. Lochhead.—Changes in the Glomeruli and Tubules of the Kidney accompanying Activity: Prof. T. G. Brodie and J. J. Mackenzie.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Copper Queen Mines and Works, Arizona, U.S.A. (1) Historical Sketch: J. Douglas. (2) Geology of the Bisbee Ore Deposits: A. Notman. (3) The Power Plant at Bisbee, Arizona; (4) The Power Plant at Douglas, Arizona: C. Legrand. (5) Reduction Works at Douglas, Arizona: G. B Lee.—Copper Smelting Methods at Bogoslowsk, Perm, Russia: R. Davey.

LINNEAN SOCIETY, at 8.—The Anatomy of the Larva of *Phryganea stricta*: R. H. Deakin.—Views of Spartina Vegetation (lantern-slides). Dr Otto Stapf.—A Seven-winged Fruit of Sycamore: W. B. Turrill.—The Genera Radamæa, Benth., and Nesogenes, A. DC: W. Hemsley.—Marine Algæ collected by Mr. C. Crossland, Part II.: Prof. R. J. Harvey Gibson and Miss Margery Knight.

FRIDAY, FEBRUARY 21.

ROYAL INSTITUTION, at 9.—Horticultural Investigations at the Woburn Experimental Fruit Farm: Spencer U. Pickering.

SATURDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom Sir J. J. Thomson, O.M.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—*Choneziphius moorei*, a New Species of Fossil Ziphioid Whale, from Walton-Naze: A. Bell.—The Legendary Folk-lore of Amulets, Charms, and Mascots: E. Lovett.

MONDAY, FEBRUARY 24.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

ROYAL SOCIETY OF ARTS, at 8.—The Art of Miniature Painting: C. Davenport.

INSTITUTE OF ACTUARIES, at 5.—"House Purchase" Companies: The "Bond Investment" Sections of the 1909 Act and Some Actuarial Features of the Business returned thereunder: C. H. Maltby.

TUESDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 3.—The Movements of the Stars. (1) The Nebular Hypothesis: Prof. H. H. Turner.

ROYAL SOCIETY OF ARTS, at 4.30.—Openings for Educated Women in Canada. Ella C. Sykes.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Erection of the Boucanne River Viaduct, Canada: P. L. Pratley.

WEDNESDAY, FEBRUARY 26.

GEOLOGICAL SOCIETY, at 8.—The Geology of Bardsey Island (Carnarvonshire): Dr. C. A. Matley. (With an Appendix on the Petrography, by Dr. J. S. Flett.)—The Loch Awe Syncline (Argyllshire). E. B. Bailey.

AERONAUTICAL SOCIETY, at 8.30.—Military Aviation: Major F. H. Sykes.

ROYAL SOCIETY OF ARTS, at 8.—The Education and Employment of the Blind: H. J. Wilson.

THURSDAY, FEBRUARY 27.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* The Thermal Properties of Carbonic Acid at Low Temperatures: C. F. Jenkin and D. R. Pye.—Re-reductions of Dover Tidal Observations, 1883–1884: E. Roberts.

CONCRETE INSTITUTE, at 7.30.—Economy in the Design of Reinforced Concrete: J. A. Davenport.

SOCIETY OF DYERS AND COLOURISTS, at 8.—Starch and Decomposition Products: Dr. M. Hamburg.—A Method for the Testing of Malt Extracts R. J May.—The Valuation of Malt Products: W. P. Dreaper.—A Contribution to the Methods of Testing Malt Extracts: Dr. A. Herz.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Fourth Kelvin Lecture—The Ohm, the Ampere, the Volt, A Memory of Fifty Years (1862–1912): Dr. R. T. Glazebrook.

FRIDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 9.—Active Nitrogen: Hon. R. J. Strutt.

PHYSICAL SOCIETY, at 5.

SATURDAY, MARCH 1.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

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NATURE

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

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THURSDAY, FEBRUARY 27, 1913.

BOTANY FOR STUDENTS.

A Text-Book of Botany. By Dr. Eduard Strasburger, Dr. Ludwig Jost, Dr. Heinrich Schenk and Dr. George Karsten. Fourth English edition, revised with the tenth German edition by Prof. W. H. Lang, F.R.S. Pp. xi+767. (London: Macmillan and Co., Ltd., 1912.) Price 18*s*. net.

FOUR years have passed since the last English edition of this comprehensive German text-book was published, and the present volume, revised by Dr. Lang, is by far the most satisfactory edition of the book which has yet appeared. The book has been very widely used by English-speaking botanists, though it is far from being an ideal work either for students or for teachers. With the rapid development of botanical research there has been a corresponding increase in the subject-matter dealt with until the volume is now uncomfortably bulky and heavy. The attempt to deal with botanical science in the most comprehensive manner, which is the aim of this text-book, has resulted in the former editions in undue condensation of the subject-matter. This defect is still very marked in the present volume and seriously impairs the value of the work.

The arrangement follows that of previous editions, namely, two parts devoted to general botany—including morphology and physiology—and special botany, comprising cryptogams and phanerogams. The first part consists of 325 pages, and in the second section, physiology, the pages for the most part are closely printed with small type.

With characteristic thoroughness the German authors appear to have included the last word in each branch of the subject, but there is also the tendency, when so many points have to be mentioned, that a large number of important subjects receive too short a notice to allow of adequate explanation. This defect has all along been particularly noticeable in the morphological section of the volume. In the present edition the structure of the sieve tube, for instance, is dismissed in about half a page of text with some indifferent figures—a treatment far too meagre to be within the unaided comprehension of the ordinary student. Germination, too, receives but the scantiest treatment.

It is true that references to all the most recent work are given, but surely it would have tended to a more liberal education in botany to deal at greater length with the fundamental facts and to put aside some of the minutiæ of detail. There is very little use in placing ornamented crockets on the pinnacles of a tower if the whole structure is likely to collapse from insecure foundations. In this, however, our plaint is not against Dr. Lang but is directed rather towards the authors of the book. The defect is probably due to the fact that they have had to compress matter sufficient for two volumes into one, and have become frightened at the size of the result. If, in the future, part i. should be separated from part ii. it may then be found possible to extend adequately and fundamentally the sections of morphology and physiology. The physiological section has now become one of the most useful in the book and is, if anything, too careful to be thoroughly abreast of modern work. Like the first section it tends to suffer from condensation and too brief treatment of the various subjects. As an instance it may be pointed out that the explanation of so important a phenomenon as plasmolysis fails to be wholly intelligible.

The second part is as comprehensive as the first. Among the fungi the recent work by Blackman and others is included with illustrations, and the utmost care has been taken to put the reader in possession of the latest results. The inclusion of fossil types where needed to explain the sequence of plant forms is a distinct addition to the book. Our chief quarrel with the phanerogamic section, and with the cryptogamic to a lesser extent, is the inclusion of the coloured illustrations, which are poor in themselves and are not likely to be of much service to British students.

The defects from which this volume suffers may perhaps be attributed to two facts, the first being that it is a compound work, and the second and more important that it has been written to meet the requirements of too many different classes of people.

The science of botany is presented as a concentrated extract of dry facts and the subject is very largely shorn of its romance and charm. There can be no doubt, however, that it ought to be possible for the intelligent examinee to obtain the maximum number of marks in his examination after a careful study of this volume.

Suitable though it may be for the various types of German students and serviceable as it undoubtedly is to English-speaking students, we cannot but feel regret, despite its many excellent qualities, that this book is coming to be recognised as the standard text-book of botany in English.

D D

MODERN PHYSICS.

(1) *Studies in Radioactivity.* By Prof. W. H. Bragg, F.R.S. Pp. xi+196. Macmillan's Science Monographs. (London: Macmillan and Co., Ltd., 1912.) Price 5*s.* net.

(2) *The Electrical Properties of Flames and of Incandescent Solids.* By Prof. H. A. Wilson, F.R.S. Pp. vii+119 (London: University of London Press; Hodder and Stoughton, 1912.) Price 6*s.* net.

It is seldom in the history of any science that three fundamental discoveries are included within the brief space of three years. The discovery of X-rays in 1895 marks a new epoch in the history of physical science, for it led early in 1896 to the discovery of radio-activity and was followed in 1897 by the proof of the nature of the kathode rays and the advent of the electron as a definite entity. In the following years an ever-increasing fraction of the energy of workers in physics has been devoted to a study of the numerous important problems which have arisen from these three primary discoveries.

In the early stages of the experimental inquiry a discussion of these subjects was conveniently included in single treatises on the conduction of electricity through gases and on radio-activity. With the rapid increase of our knowledge of the various subdivisions of the subject it was inevitable that special treatises would be necessary to discuss in more detail the results of recent investigations. This is illustrated by the separate publications that have appeared on the theory of electrons, ionisation by collision, and the chemistry of the radio-active bodies. This tendency towards specialisation is in many respects advantageous provided two conditions are fulfilled. In the first place, it is essential that the subject should be treated by experts who have taken an active part in the development of our knowledge of the topics under consideration; in the second place, it is of great importance that the author, in the extended treatment of the subject, should not lose sight of its connection with the main stream of advance in physics, both experimental and theoretical.

The two books under review fulfil these conditions in an ideal manner, for they are both written by men who have made notable contributions to our knowledge of the subjects under consideration, and have that requisite knowledge of modern physical views to treat the subjects in the right perspective.

(1) The work of Prof. Bragg deals mainly with the phenomena accompanying the passage of α, β and γ rays and X-rays through matter. An interesting account is given of the theoretical reasoning that led the author to predict the nature of the absorption of the α rays by matter, and of the admirable experiments made by him which led to such an important extension of our knowledge of this subject. The results of experiments on the passage of X-rays through matter are interpreted on his well-known corpuscular theory of the X-ray. The essential point of this theory is that the energy of the X-ray is corpuscular in the sense that it is concentrated and does not spread from the source like that to be expected in an ordinary pulse or wave. In addition, it is supposed that the β ray and the X-ray are mutually convertible forms of energy. When a β ray disappears as a result of a close encounter with an atom, an X-ray of equal energy takes its place and tends to be propagated in the original direction of the β ray. This theory has the advantage of giving a concrete and easily grasped idea of the processes occurring in the passage of X-rays through matter, and has served a very useful purpose in directing numerous investigations which have thrown much light on the subject.

It is remarkable that although more than seventeen years have elapsed since the discovery of X-rays, there is still a great difference of opinion as to their nature and the mechanism of their absorption by matter. The recent striking experiments of Laue and his colleagues, supplemented by the explanation of Mr. W. L. Bragg, seem to show conclusively that a fraction of the X-rays suffer regular reflection at the crystal planes of mica and of other crystals. These results seem only compatible with the view that the X-rays are some type of wave motion. On the other hand, the liberation of a high-speed electron from an atom traversed by the X-ray cannot be explained with any credibility unless it be supposed that the energy of the X-ray is concentrated over a minute volume, and can be given up in an encounter with a single atom. These apparently conflicting but fundamental properties of the X-ray must be reconciled in any satisfactory theory of the X-rays.

The book is very pleasantly and clearly written and contains a concise account of most of the important experiments on the subject under consideration. While there will, no doubt, be considerable difference of opinion as to the merits of the theories proposed by the writer, the book can be strongly recommended not only to the physicist, but to all those who are interested in the fascinating field of inquiry which has been opened up by the discovery of new types of penetrating radiation.

(2) The work of Prof. H. A. Wilson is confined to a discussion of the electrical properties of incandescent bodies and of flames. Under the influence of the ionisation theory of gases this important field of inquiry has rapidly developed, and a large amount of experimental data has now been accumulated. An account is first given of the character and conditions of the discharge of negative and positive electricity from glowing bodies, followed by a discussion of the conductivity of flames under different conditions. It has been clearly established that the rapid discharge of electricity from hot bodies is due to the escape of free electrons, and the author discusses the result in the light of the theory developed partly by himself and partly by Prof. O. W. Richardson. This theory supposes that the free electrons in a metal acquire sufficient velocity at high temperatures to escape from the metal and to give rise to the observed discharge of negative electricity.

The earlier experiments certainly afforded strong ground for this conclusion. Since the publication of this book, however, experiments have been made by Pring and Parker and others which throw same doubt on the completeness of this explanation. It has been shown that carbon at very high temperatures and in a thoroughly exhausted space gives only a minute fraction of the current to be expected from the application of the theory to the earlier measurements at lower temperatures. There seems to be little doubt that, at any rate in the case of glowing carbon, the large electronic currents initially observed were due not to the escape of electrons in the carbon itself, but rather to some interaction between the carbon and the residual gases. The theory of the subject is at present in a somewhat unsatisfactory state, and it would appear that more complete experimental data are required before any theory can be adequately tested.

Prof. Wilson gives a brief but concise account of the important experiments on the subject, followed in every case by a discussion of the results in the light of the theories proposed. An excellent description is given of the experiments on flames with and without the additions of salt vapours, and the results are interpreted in terms of the ionisation theory. The author himself was a pioneer in this field and laid the foundation of the present theory on a firm basis of experiment.

The book is in no sense popular, but is written for the advanced student or investigator who is already familiar with the fundamental facts of the electronic theory and the ionisation theory of gases. It will be found very useful by all physicists as giving a concise and straightforward account of the present state of our knowledge of a very interesting but difficult field of investigation.

E. R.

PHILOSOPHY AND PSYCHOLOGY.

(1) *The Nature of Woman.* By J. Lionel Tayler. Pp. 186. (London: A. C. Fifield, 1912.) Price 3*s*. 6*d*. net.

(2) *The Fundamentals of Psychology.* By B. Dumville. Pp. ix + 382. (London: W. B. Clive, 1912.) Price 4*s*. 6*d*.

(3) *Evolution and the Need of Atonement.* By Stewart A. McDowall. Pp. xvi + 155. (Cambridge: University Press, 1912.) Price 3*s*. net.

(4) *On the Consciousness of the Universal and the Individual.* By Dr. F. Aveling. Pp. x + 255. (London: Macmillan and Co., Ltd., 1912.) Price 5*s*. net.

(5) *Science and the Human Mind.* By W. C. D. Whetham, F.R.S., and Catherine D. Whetham. Pp. xi + 304. (London: Longmans, Green and Co., 1912.) Price 5*s*. net.

(6) *The Note-Books of Samuel Butler, Author of "Erewhon."* Selections arranged and edited by Henry F. Jones. Pp. xii + 438. (London: A. C. Fifield, 1912.) Price 6*s*. net.

(7) *The Spiritual Interpretation of Nature.* By Dr. J. Y. Simpson. Pp. xv + 383. (London: Hodder and Stoughton, 1912.) Price 6*s*. net.

(8) *Papers on Psycho-Analysis.* By Dr. E. Jones. Pp. xv + 432. (London: Baillière, Tindall and Cox, 1913.) Price 10*s*. 6*d*. net.

(9) *Questions of the Day in Philosophy and Psychology.* By Dr. H. L. Stewart. Pp. x + 284. (London: Edward Arnold, 1912.) Price 10*s*. 6*d*. net.

(1) A DESCRIPTION, historical and biological, of the feminist movement. The conclusions of the author, who is a London University Extension lecturer on biology and sociology, are: that woman, not being merely a female man, but of different aptitudes, has her own proper sphere and direction of development; that her speciality is motherhood—not merely the physical fact, but also the ennobling influences involved; that the married woman should not work in factories, &c., but should be economically dependent on the man, as he is domestically dependent on her; and that a standard marriageable wage should be secured to the male worker. The book closes with a reprint of W. C. Roscoe's article, "Woman," in *The National Review* for October, 1858. In this pioneer essay, "every

argument of real strength for and against the woman's movement, that has been used in the fifty odd years that followed its publication, will be found summarised."

(2) A good text-book, more than elementary and well adapted for its purpose as a guide to teachers. It follows James and McDougall for the most part, and is provided with suitable questions at the end of each chapter. Its scheme is the usual modern one: first, the physiology of sensation, then perception, imagination, ideation, memory, conation, feeling, instincts. Throughout, the practical application to the child-mind is kept in view, and the writing is clear and good. Mr. Dumville is master of method and lecturer on education in the L.C.C. Islington Day Training College.

(3) Mr. McDowall accepts the scientific view of biological evolution, carrying it forward to a higher plane. He suggests that the fact of spiritual development demands a determining environment to call out spiritual activities. This he conceives as a transcendent mind which comprehends, enfolds, includes the environment-sum of the whole world. Man, however, has sinned, being free; and his only way of salvation is to "accept Christ"—though if he fails to do so in this life he may have a chance in the next. Bishop Ryle supplies a eulogistic introduction to the book, which is thoughtful and earnest, and will doubtless be of use to many readers who feel the need of harmonising theology with natural science.

(4) Dr. Aveling sketches the history of the problem of universals or general terms—*i.e.* roughly speaking, what "man" means, apart from this or that man—from Plato down to the present, and then proceeds to give a detailed account of his psychological experiments. These were carried out with pictures and nonsense-words, with various observers. The results led to the conclusions—among others—that images are not necessary as contents for thought, but thinking always involves concepts as contents; and that "the 'universal' is phenomenologically present, or tends to be present, to consciousness as a concept or imageless substantive content." The research was, of course, psychological, aiming at answering the question: "What is discoverable in consciousness when we think the 'universal' or the 'individual'?" The metaphysical question ("Do universals exist in nature?") and the epistemological question ("Do our universal ideas correspond to reality?") are naturally left to their respective domains.

(5) Mr. and Mrs. Whetham have once more produced an admirably readable yet trustworthy popular-science book, and it is to be hoped that it will circulate widely. The authors trace the development of science from its dim beginnings—dim so far as history is concerned—in Chaldea and Egypt, down through Aristotle, the Arabians, Aquinas, and the Renaissance, to the Baconian period and the present day—including even such recent events as Prof. Schäfer's Dundee address. As becomes a historical survey, dogmatism and partisanship are avoided, the authors refraining from expressions of opinion on, *e.g.*, vitalism. The style is enlivened by a pleasant humour, as when the Council of Nicæa is said to have met, "with characteristic modesty, to determine the true nature of God" (p. 67), and the sequence of the book is logical and smooth. Its philosophy also is excellent, and many men of science might do worse than read the last two chapters on the scope and function of science, and its relation to religion. The "laws of nature" are the logical laws of the conceptual world formed by our own minds, and these laws are of practical use in enabling us to predict the future behaviour of our own perceptions. The business of science is to construct a consistent conceptual model, but how far that model corresponds to "reality" is not for science to say, nor can it be assumed to represent reality in any final or total way. In short, there is room for metaphysics and faith by the side of science.

(6) The whimsical genius of Samuel Butler is best known through the satirical romance "Erewhon," but his "Life and Habit" and "Unconscious Memory" show him as a serious thinker, of scientific methods, but with a spiritual and teleological view of evolution, in which he was in advance of his time. But his title to fame will probably rest on his literary style and the flashing audacity and originality of his thoughts. This is specially indicated in the volume under notice, which consists of detached and fragmentary notions, jotted down at odd times, on all subjects, from Handel to death, from mind and matter to painting. His criticisms are cruelly searching, as when he compares Pater's style to an old woman who has had her face skilfully enamelled. It is a good book to dip into when seeking smart paradoxes. We recommend it to Mr. G. K. Chesterton, of whom Butler often reminds us. Mr. Chesterton will rightly take this as a compliment when he reflects that his friend G. B. Shaw has called Butler the greatest English writer, in his own department, of the latter part of the nineteenth century.

(7) A very similar book to Mr. McDowall's

above-noticed, but on a larger scale and more detailed in its sketch of biological evolution. Dr. Simpson is orthodox in his science, but on the religious side conceives a World Principle immanent and transcendent, yet personal. "Of course, we cannot form a clear conception of such infinite, unconditioned personality. We are certain that it is something richer in content than our personality." The problem of sin is very well handled: the Genesis narrative is symbolically true, but does not teach that man fell from a state of goodness. On the contrary, he has risen from a state of *innocency*, such as the child's state before he learns to recognise good and evil. He must continue to rise, until he reaches communion with God through likeness to Him. The book contains much that is theologically and philosophically debatable, but is an excellent example of the modern literature of reconciliation, and does credit both to the learning and the piety of its author.

(8) Dr. Jones dedicates his book to Prof. Freud, among whose disciples he enrolls himself. Many interesting illustrations are given, showing the influence of subconscious desires in producing lapses of memory and the like. Other chapters deal with the relation between organic and functional diseases, simulation in hysteria, the pathology of morbid anxiety, the action of suggestion in psychotherapy, Freud's theory of dreams, and psycho-analysis and education. The writer is associate-professor of psychiatry in the University of Toronto. His book is extremely readable and good, chiefly by reason of its wealth of concrete examples. We may incline to think that the Freudian psychology is itself obsessed with sex-ideas, and is guilty of tracing everything to subconscious sexual thoughts or desires; but, after all, a theory is best tested by its thorough application to facts, and there is no doubt that Freud is a pioneer, comparable—it may be, as Dr. Jones suggests—with Darwin himself.

(9) These essays are, in the main, an expansion of a course of lectures delivered in the Queen's University of Belfast. They deal with subconsciousness, genius, pragmatism, pessimism, Nietzsche, &c. The opinions are well and temperately stated, and we only discover one dubious statement of fact—viz., that 98 per cent. of all classes of persons are hypnotisable. This percentage is much higher than the average opinion of experts would allow. The author follows Myers in his psychology, according well-merited praise to that writer and to the careful work of the Society for Psychical Research.

J. A. H.

MATHEMATICAL TEXT-BOOKS.

(1) *Exercises in Modern Arithmetic*. By H. Sydney Jones. Pp. x+336. (London: Macmillan and Co., Ltd., 1912.) Price 2*s*. 6*d*.

(2) *Notes on Algebra*. By A. F. van der Heyden. Pp. viii+133. (Middlesbrough: Wm. Appleyard and Sons, Ltd, 1912.) Price 2*s*. 6*d*.

(3) *The Teaching of Mathematics in Secondary Schools*. By Arthur Schultze. Pp. xxi+370. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 5*s*. 6*d*. net.

(4) *Higher Algebra for Colleges and Secondary Schools*. By Dr. Charles Davison. Pp. viii+320. (Cambridge: University Press, 1912.) Price 6*s*.

(5) *Non-Euclidean Geometry: A Critical and Historical Study of its Development*. By Prof. Roberto Bonola. Authorised English translation with additional appendices. By Prof. H. S. Carslaw. With an Introduction by Prof. Federigo Enriques. Pp. xii+268. (Chicago: The Open Court Publishing Company, 1912.) Price 2 dollars net.

(6) *An Introduction to the Infinitesimal Calculus*. Notes for the use of Science and Engineering Students. By Prof. H. S. Carslaw. Pp. xii+137. (London: Longmans, Green and Co., 1912.) Price 5*s*. net.

(1) THIS volume consists of the examples reprinted from the author's work entitled "Modern Arithmetic with Graphic and Practical Exercises." The range covered is that required for the Oxford and Cambridge Local examinations. The quality of the examples, which are mainly of a practical character, is good. A number of typical examination papers are given at the end of the book.

(2) This note-book is intended for students who are revising the subject, not for those breaking new ground. There is much interesting historical information; but we are inclined to think that the treatment is scarcely sufficiently thorough for many purposes. For example, none but the simplest tests of convergence are given, the theory of numbers is represented by Fermat's theorem alone, and the method given for resolving partial fractions is inadequate. The geometrical representation of complex numbers, Demoivre's theorem and its applications are included.

(3) The object of the author in publishing this volume is to show that the purpose of a mathematical training is best served by making the course less informational and more disciplinary than is at present customary. He contends, and

with some truth, that the majority of teachers aim at impressing a set of facts upon their pupils rather than training them how to attack and discuss mathematical problems. Unfortunately, there are few teachers who are free agents; the requirements of the various examining boards must first be satisfied before personal individuality can be freely exercised, and much of the best work of the first-rate teacher is of a character that examinations can scarcely test. At the same time, mathematical teachers should undoubtedly know something of the science of teaching, and cannot fail to profit by a knowledge of the experience of others. In the present volume, there is much of real interest and value. After preliminary general discussions, the author examines in great detail the theory of geometrical teaching and somewhat briefly the elements of a suitable course in algebra and trigonometry. Such a work as this should find a place in the common-room libraries of our secondary schools.

(4) This is a continuation of the author's former treatise on algebra for secondary schools. It opens with the binomial theorem and includes all that usually finds a place in an advanced school course. Among the chief features of the book may be noted an excellent chapter on complex quantity; the geometry of vectors is developed, and the use of trigonometric functions renders the account reasonably complete. By introducing the notation of the calculus, the treatment of limits is simplified and the usual applications in the theory of equations become possible. The work on continued fractions is put rather more briefly than usual, but nothing of importance for any ordinary purpose has been omitted. The volume has an attractive appearance, the examples are really good, and the essay questions at the end will be of great assistance to scholarship candidates.

(5) The study of non-Euclidean geometry has, till recently, attracted the attention only of the specialist; no doubt this has been due principally to the general belief that the difficulties were so considerable, the philosophical problems so intricate, and the subject so contrary to ordinary experience that the ordinary mathematician would, without prolonged study, make little of it. Time, however, invariably lowers the levels and extends the boundaries of the territory accessible to ordinary students. There are now a number of elementary text-books which make its pursuit a comparatively easy task. There are two valuable studies by Mr. Frankland—"The Theories of Parallelism" and "Euclid I., with a Commentary"—there is a primer by Prof. Manning, a more elaborate treatise by Prof. Coolidge, and, for those who read German, the works of Killing, Liebmann, Hilbert, Vahlen, etc.

The translation of Prof. Bonola's valuable critical and historical summary will be of the greatest assistance to students. The book opens with an account of the attempts to prove Euclid's parallel postulate which were made from the time of the Greek geometers down to the seventeenth century. The next section deals with the period when men were first beginning to inquire whether a form of geometry could exist independently of this postulate. This work is associated with the names of Saccheri, Lambert, Wolfang Bolyai and others; but it was not until the time of Gauss, Taurinus, Lobatschewsky, and Johann Bolyai that the foundations of non-Euclidean geometry were securely laid. A most interesting sketch is given of the growth of thought in this period. The concluding chapter discusses the later work of Riemann, Helmholtz, Lie, Cayley, Klein, etc. There are five appendices; these deal with (*a*) the fundamental principles of statics; (*b*) Clifford's parallels; (*c*) constructions; (*d*) the independence of projective geometry; (*e*) a method of exhibiting the impossibility of proving Euclid's postulate by a consideration of the analogous geometry of a system of circles orthogonal to a fixed circle. This last appendix, which is due to Prof. Carslaw and is based on Wellstein's work, establishes, by an elementary and elegant method, a number of interesting theorems in hyperbolic geometry.

(6) These notes on the calculus, drawn up for science and engineering students, are intended to supplement the earlier parts of the ordinary textbooks. The first chapter gives the analytical geometry of the straight line, the second illustrates the meaning of differentiation by examples from physics and geometry; in the next three the rules for differentiations are given; and the last two, after a few pages on the geometry of the conic, give an account of integration and its applications.

OUR BOOKSHELF.

Kausale und konditionale Weltanschauung. By Max Verworn. Pp. 46. (Jena: Gustav Fischer, 1912.) Price 1 mark.

EVEN when one profoundly disagrees, it is always a pleasure to listen to Prof. Max Verworn, for he has clear-cut convictions which he states vividly and with enthusiasm. The present essay is an exposition of "conditionism" as contrasted with "causalism," and it deals hard blows at vitalism, dualism, entelechy, free will, and other naïve and uncritical assumptions, as Verworn thinks.

It may be of interest to state the five propositions of conditionism:—(1) There are no isolated or absolute things. All things, *i.e.* all processes and states, are conditioned by other processes or states. (2) There is no process or state which is dependent on a single factor. All processes or states are conditioned by numerous factors. (3) Every process or state is inevitably determined by the sum of its conditions. Only under similar conditions do similar processes or states occur, and, conversely, different processes and states presuppose different conditions. (4) Every process or state is identical with the sum of its conditions. The totality of the conditions is the process or state. (5) All the conditions of a process or state are of equal value for its occurrence in so far as they are necessary. But it does not seem difficult to accept all these propositions and yet remain a good vitalist.

Dizionario di Merceologia e di Chimica Applicata. By Prof. V. Villavecchia. Terza editione. Vol. ii. Lettere N–Z e Indice. Pp. 1360. (Milan: Ulrico Hoepli, 1913.) Price 15 lire.

THE scope of this work and its especial features were explained when the first volume was reviewed. The second volume embraces articles from N to Z, and occupies 1170 half pages. All the articles are written very concisely; in fact, so concisely that, *e.g.*, the author has not yielded to the temptation to do more than mention the Italian occurrences of petroleum in the article "Petrolio greggio."

The remainder of the work, covering 200 pages, forms a very complete index. It is carried through in four languages, and includes also botanical and zoological names. Thus this index very greatly assists the reader who is not sufficiently conversant with the Italian language to depend on the alphabetical arrangement of the subject-matter in the body of the two volumes.

The Vertebrate Skeleton. By Prof. Sidney H. Reynolds. Pp. xvi+535. Second edition. (Cambridge: University Press, 1913.) Price 15*s.* net.

THIS work, belonging to the Cambridge Zoological series, was reviewed at length in the issue of NATURE for July 15, 1897 (vol. lvi., p. 245), at the time of its original publication. The present edition has been revised and brought up to date. Prof. S. W. Williston has assisted Prof. Reynolds in this work, having rewritten the chapter on the Sauropsida and that on the general account of the skeleton in reptiles, as well as contributing some notes on birds and on the Stegocephalia.

Heaton's Annual: the Commercial Handbook of Canada and Boards of Trade Register, 1913. Edited by E. Heaton and J. B. Robinson. Pp. 401. (Toronto: Heaton's Agency; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 5*s.*

THE ninth issue of this yearly handbook dealing with the resources of Canada is full of interest. It will prove directly useful to teachers of commercial geography, and much of the general information it provides will appeal to scientific readers.

LETTERS TO THE EDITOR.

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

On the Appearance of Helium and Neon in Vacuum Tubes.

SINCE reading before the Chemical Society (see NATURE, February 13, p. 653) the paper on the presence of helium and neon in vacuum tubes (containing hydrogen) after the gas had been sparked, we have carefully compared the spectrum lines that are supposed to be characteristic of these gases. The result has been interesting. In the case of neon and hydrogen there appears to be a large number of lines in the secondary spectrum of hydrogen that are very close to the important lines of neon. If only those lines are taken that differ by less than a quarter of an Ångström unit (using the measurements of Watson), there are fifty-seven instances. It is not necessary to give all of them, but if the neon lines of intensity 4 and greater be taken it is found that there are twenty instances:—

Intensity	Neon	Hydrogen	Intensity	Neon	Hydrogen
9	6506·69	6506·82	4	5872·27	5872·12
10	6402·43	6402·51	10	5852·62	5852·72
9	6383·14	6383·20	4	5760·74	5760·58
5	6175·09	6175·14	7	5343·40	5343·43
7	6143·31	6143·30	4	5122·40	5122·64
6	6096·36	6096·21	6	5080·52	5080·73
6	6074·51	6074·66	4	4537·93	4537·91
5	6030·20	6030·30	4	3682·37	3682·20
5	5975·76	5975·68	9	3520·61	3520·60
5	5882·06	5882·17	6	3472·68	3472·65

Moreover, according to Watson there are only two neon lines of intensity 10, and only four of intensity 9. Of these six principal neon lines, five are paralleled in the secondary hydrogen spectrum, and the sixth line of neon (of intensity 9), 6334·65, is near to a hydrogen one, 6335·53.

There are also fifty-three neon lines that differ from those of the secondary hydrogen spectrum by less than one Angström unit and by more than a quarter. This makes 110 lines that are paralleled in the two spectra.

In the case of neon and helium there are also a series of lines that run parallel. Three of these lines were pointed out by Watson (Proc. Roy. Soc., vol. lxxxi., p. 185). He says: "The lines at 6678 and 3447, however, were very bright on the same plate, and it must be concluded that there are two neon lines almost coincident with the helium lines." "There appears to be a similar pair at 4713, though I was unable to obtain a plate on which the neon line alone was present. The wave-lengths of the lines concerned are:—

He	6678·37	4713·25	3447·73
Ne	6678·50	4713·51	3447·83

And no reason can be at present assigned to their close proximity."

In the case of neon and oxygen, one of the two bright neon lines of intensity 8 and wave-length 5330·90 is very near to a bright oxygen line wave-length 5330·84.

J. NORMAN COLLIE.
HUBERT S. PATTERSON.

February 22.

The Occurrence of the Portuguese Man-of-War (Physalia), and of a Giant Spider-Crab, "Homola (Paromola) cuvieri," in the English Channel.

THE occurrence of the Portuguese man-of-war (Physalia) on the English coast is so unusual as to be well worth recording. During March and the early part of April, 1912, numbers of the Atlantic form of Physalia were cast up on our shores at various points between Cardigan Bay and Seaford in Sussex. It was also reported by M. Caullery[1] as occurring along with Velella on the French side of the Straits of Dover in the early part of April, 1912. Specimens were also sent to this laboratory on February 10 this year from Looe, on the south coast of Cornwall. There can be little doubt that the presence of Physalia on the south coast of England in March and April, 1912, was due to the almost continuous high southerly to south-westerly winds indicated in the south-eastern part of the North Atlantic in the meteorological reports for the early part of that year.

Physalia is believed to occur normally only in the warmer currents of the Atlantic Ocean,[2] but in the early months of the year large specimens are not infrequently blown into the Mediterranean, and after storms thousands have been found about the same time of the year on the beaches of the Canary Islands. It is therefore not improbable that the Physalia stranded on the English coasts had been driven by the wind from the eastern portion of the subtropical North Atlantic.

It is interesting to note that at the end of March northerly winds set in in the eastern part of the English Channel. This circumstance probably explains why Physalia and Velella were driven on to the French side of the Straits of Dover.

It may also be of interest to mention that a specimen of the very large spider-crab *Homola* (*Paromola*) *cuvieri* has been taken for the first time on record in the English Channel. The specimen is a very fine male. When the large clawed legs are held out at right angles to the body, the span is nearly 4 ft. (117·3 cm.), while the length of the carapace is rather more than 6½ in. (16·6 cm.). We are informed by Messrs. M. Dunn and Sons, who presented the crab to the Marine Biological Laboratory at Plymouth, that it was taken by fishermen on December 16 last, in a trammel-net three-quarters of a mile E.S.E. of Pen-a-Maen Point (north-east of Dodman Point), on the Cornish coast. At this spot the depth of water is about 15 fathoms, whereas in the Mediterranean this crab is said to inhabit the deeper waters, and has been taken there in about 215 fathoms. Off the north-west coast of Africa[3] it has indeed been recorded from a depth of 350 fathoms.

There is an abundant growth of marine animals (viz. Anomia, Pomatoceros, Serpula, Sabella, Botryllus, Antennularia, Ascidiella, Plumularia) on the back and legs of the crab, a fact which seems to indicate that the animal has been living at least some months in relatively shallow water. This specimen of Homola is still living in the tanks at the Marine Biological Laboratory, and is feeding well.

The occurrence of Homola in the English Channel is one more instance of the close relationship of the fauna of this region with that of the Mediterranean and neighbouring parts of the Atlantic. Homola, however, has been recorded rarely from the west coasts of Ireland and Scotland,[4] hence there is the possibility that this northern distribution may have been effected partially by means of the current which flows from the Mediterranean, and is believed to spread along the western shores of Europe. There is, moreover, reason to believe that the more typical planktonic forms of life might be carried considerable distances in such a wind-drift as that in which Physalia must have been. It is not suggested, however, that the larvæ of Homola, for example, would be driven so far as Physalia and Velella in similar circumstances, for it is well known that these two Siphonophores, inasmuch as they are semi-aërial, comprise a separate category of plankton with regard to their adaptation for distribution.

The recent distribution of Physalia may therefore be said to offer us a picture by means of which we can more readily understand, for example, the close relationship between the fauna of the English Channel and that of the Mediterranean and neighbouring Atlantic region.

J. H. ORTON.

The Laboratory, Plymouth.

[1] M. Caullery, *Bull. de la Soc. Zool. de France*, tome xxxvii., 1912, pp. [illegible].

[2] C. Chun, "Ergeb. der Plankton-Exped." Die Siphonophoren, Bd. II., [illegible], p. 80.

[3] A. Milne Edwards and E. L.-L. Bouvier, "Expéditions Scientifiques du Travailleur et du Talisman." Crust. Decap., I., 1900, p. 10.

[4] "Guide to Crustacea, &c. Exhibited in the Department of Zoology, British Museum (Natural History), 1910," p. 66.

Actual Conditions affecting Icebergs.

IN the interesting discussion by Dr. Aitken on the relation between laboratory experiments and actual conditions, as affecting icebergs (NATURE, January 9), there is one element of primary importance which appears to be too much overlooked. To put it in the most general terms, icebergs are almost always moving in the drift of an ocean current; and the point to which I wish to direct attention is the relative movement of the water with respect to the iceberg.

It is the nature of constant currents to have a greater speed at the surface and to decrease in velocity with the depth. This is a usual characteristic, as found in my investigations in the Tidal and Current Survey, in several such currents. For example, when the surface speed is one knot or more the velocity may fall to about half this at 30 fathoms, and it may be only distinctly appreciable at 90 fathoms. An iceberg in such a current will, of course, move with the average velocity corresponding to its draught, and, as a consequence, the *normal* condition is that an iceberg has a superficial current running past it. It is also probable that this current will usually be much greater than such movements of the water around it as are set up by convection, from difference of temperature.

It is also to be noted that this relative movement is independent of wind disturbance and tidal effect, which often accentuate it. In the work of this Survey, I have had ample opportunity to observe these effects while at anchor in the open amongst icebergs for days at a time. In Belle Isle strait, they ground in a depth of 30 or even 50 fathoms, which shows the draught they may have; and the strong tidal streams of 2 to 2½ knots running past them create a wake behind them, like a vessel under sail. This may be considered an unusual condition, but it should not be overlooked in discussing practical safeguards, for an iceberg aground on the 30-fathom bank in the middle of Belle Isle strait is as much of a menace to navigation as any.

Although there may thus be many modifications of general conditions, it will be on the safe side to assume in this discussion that there is always a superficial current of appreciable amount flowing past an iceberg, even in the open, while it is carried along in any berg-bearing current.

W. BELL DAWSON.

(Superintendent of Tidal and Current Surveys, of Canada.)

Ottawa, Canada, January 25.

FRESH LIGHT ON THE CAUSE OF CANCER.

Prof. Johannes Fibiger, of Copenhagen, describes in a long article in the *Berliner klinische Wochenschrift* for February 17 some experiments which carry our knowledge of the relation between the origin of cancer and external causes a step further. The present writer has been aware of these observations since August, 1911, but they have been in progress since 1907. They have, therefore, been pursued for some five years, which indicates alike the difficulties overcome and the praiseworthy pertinacity of the investigator.

When examining growths found in the stomachs of three wild rats, Fibiger was struck by the presence of nematodes, and he set himself to determine if they stood in causal relationship to the growths or were accidental concomitants. Cancer of the stomach in mice was described by Murray in 1908 from the laboratory of the Imperial Cancer Research Fund, but at an examination undertaken in consequence of a letter from Fibiger, neither he nor we were able to show the presence of nematodes. The growths occurred in rats obtained from some sources and not from others, and their occurrence coincided with the presence of *Periplaneta americana*. From other sources he was aware of the cockroach serving as a host for round worms. The cockroaches harboured a nematode, and he studied its life-cycle. It lives in the pavement epithelium of the upper portion of the rat's alimentary canal, where it reaches sexual maturity. The eggs containing embryos are passed with the fæces, and on being consumed by the cockroach (either *P. americana* or *P. orientalis*) the embryos are liberated, and wander into the striped muscles of the prothorax and limbs. In these situations they are found after six weeks coiled up trichina-like.

When rats eat infected cockroaches, the larvæ are freed and wander into the squamous epithelial covering of the fundus of the stomach, and occasionally also into the gullet, tongue, and mouth. They do not invade the epithelium covering the rest of the canal. Fifty-seven tame rats were fed on *P. americana* infected with the Spiroptera; in fifty-four the nematode was found in the stomach, in seven the growths which had initiated the investigation were found, and in twenty-nine others there were found the earlier stages of such growths. Feeding rats with eggs containing embryos did not convey the infection. Microscopical investigation showed in the case of seven rats growths resembling the tumour originally observed, together with the certain presence of secondary deposits in other organs in the case of two and possibly of three rats. The structure of the growths was in four out of the seven definitely that of a malignant new growth.

It would appear, therefore, that for the first time malignant new growths have been deliberately produced by experiment through the agency of a living parasite. Fibiger draws the conclusion that the disease is dependent on the presence of the Spiroptera, and, on analogy with other Helminthes, assumes they act by some poison secreted, although he is not prepared to dismiss altogether the possibility of a virus or ultramicroscopical organism being concerned. All the histological pictures found form a continuous series, but they afford no clue to the mechanism of genesis. Important is the observation that the worms were only associated with the primary growths, and were absent from the secondary deposits, showing that the cells had acquired independent powers of growth.

The association of round and other worms with cancerous growths has long been known. Borrel and Haaland described this association for mice from the Institut Pasteur in 1905 for certain growths of the lung and lymph glands. The association of a tape-worm with cancer of the small intestine in mice was described by Bashford and Murray in 1905. Haaland, when working in the laboratory of the Imperial Cancer Research Fund, published an elaborate communication on the association of a nematode with cancer of the mamma in that animal. He assumed its excretions were the cause of chronic inflammation on which nodular hypertrophy, adenoma, and carcinoma developed. Its life-history—notwithstanding continued attempts made in the hope of being able to attack the problem of causal relationship directly—has not been followed to this day, but it was shown to be different from another nematode occurring in the alimentary canal, both nematodes having been identified by Mr. Shipley and Dr. Leiper. And since then there have been many other references in the literature.

The presence of the worms must not be interpreted in the sense that they are *the* cause of cancer, as has been done in the lay Press. They probably act as chronic irritants, of which a legion is associated with the development of cancer. They may be animate or inanimate, *e.g.* mere direct *physical* injury as in fracture of bone or in the "horn core" of cattle in India, *chemical* as in paraffin, petroleum, tar, arsenic, and aniline cancer, *actinic* as in the case of the short hot claypipe, the Kangri, the X-ray, or brand cancers (of cattle). Squamous-celled carcinoma develops in engine-drivers over the shin where the skin has been exposed for years to the direct action of heat. They may be of an infective nature as in Bilharzia for the bladder, the tubercle bacillus where epithelioma develops in an old lupus scar, or *Treponema pallidum*, as in the association of keratosis linguæ with epithelioma of the tongue. The irritant may be a larger parasite, such as worms.

Borrel has suggested that the latter are the carriers of a specific cancer virus; on the other hand, it has been suggested that the relation for all these irritants is a mediate one in quite a different sense, and that the common factor lies in the capacity of the living cell itself to undergo variations in structure and in powers of growth such as have been demonstrated in propagated tumours when subjected to the repeated irritation produced by transplantation, as described in the reports of the Imperial Cancer Research Fund. It unfortunate that the growths produced experimentally by Fibiger present just as much difficulty in the elucidation of the exact process as do all other natural growths.

In the past the attempt has often been made to produce cancer by subjecting animals to the irritations associated with cancer in man, but without success except possibly in the case of X-rays. As the writer has pointed out, the irritants vary from one mammal to another, and the knowledge of the irritants to which different species and even their individual organs are liable is of very considerable importance, and will require extensive study. Prof. Fibiger is to be congratulated not only in having isolated such an apparent specific irritant, but also, by carefully imitating the natural process, on having produced cancer experimentally through the mediate intervention of a parasite for the first time. E. F. BASHFORD.

THE INTERNATIONAL AERO EXHIBITION AT OLYMPIA.

THE development of the details of flying machines between 1908 and the present time is immediately obvious on a visit to the Aero Exhibition; but, quite apart from the higher standard of workmanship, it is also evident that scientific principles are governing the design of aëroplanes to a greater and greater extent. Almost without exception the designs show evidence of the general desire to keep the resistance of the machines as low as possible and so get increased lifting power and speed. It is not any longer necessary to consider the bare possibility of lift, as the shape of the wings is now so good as to give about 20 lb. of lift per horse-power, and engines available for aëroplanes can be obtained of horse-powers up to 160, weighing less than 3 lb. per horse-power; such an engine can then carry, roughly, $1\frac{1}{2}$ tons, a weight greater than that of any existing aëroplane.

The reduction of resistance does not then arise from necessity, but appears to be directly due to the application of scientific principles. The chief saving in resistance arises from fewer stay-wires and in the covering of the fuselage or tail girder of almost all flying machines, although there are notable exceptions, such as the Maurice Farman biplane exhibited. As compared with the first Wright machine, the stay-wiring of modern machines looks comparatively simple, and in biplanes in particular the struts have been lengthened in the direction of the wind. The strength of the struts is often obtained from a circular steel tube, the desired section for low resistance being obtained from it by the addition of wooden tails and headpieces. The difference of resistance due to shaping the tubes may, on a biplane, increase the carrying capacity of the machine to the extent of another passenger.

The covering of the fuselage to make a streamline body has, however, other effects than that of reducing the resistance. The side surface is considerable, and becomes equivalent to a vertical fin; Prof. Bryan in his book on stability has shown mathematically, what Mr. Lanchester deduced earlier from a combination of experiment and mathematical analysis, that the position of such fins is of the greatest importance when considering the lateral stability of an aëroplane, and that great care must be taken in the arrangement of such surfaces.

One then looks at the exhibits to find how far aëroplane constructors are designing according to the principles of inherent stability, and how far they leave the control to the skill of the pilot. So far as longitudinal stability is concerned, practically all the machines at the normal flying speed satisfy the mathematical requirements for the stability of small oscillations. The essential features of inherent stability are contained in a series of planes inclined fore and aft, with the angle of incidence from plane to plane decreasing progressively from front to back and in addition having the smaller or elevator planes of sufficient area. Most of the machines, such as the Blériot, BE 2, &c., have two surfaces, the main wings and a neutral or nearly neutral tail, whilst the Cody prize machine and the Maurice Farman biplane have each three planes due to the addition of a forward elevator.

Part of the tail plane, and usually the greater part, is fixed to the fuselage of the flying machine, and exercises a control which is independent of the pilot, who is left with the adjustment of the remainder for manœuvring. An exception to this subdivision of the elevator occurs in the Breguet machine, where the whole surface is under the immediate control of the pilot. This latter arrangement has the advantage of a powerful control and the corresponding possible disadvantage of depending entirely on the strength of the pilot for the maintenance of attitude. How much the advantage outweighs the disadvantage is obviously a question to be settled later by the majority of constructors, since it is not yet widely adopted.

With the possible exception of flying at low speeds, it would seem that for longitudinal stability flying machines possess a considerable amount of inherent stability, and only call for serious assistance from the pilot in special circumstances, as when the aëroplane is struck by a gust.

Lateral stability, however, receives far greater variety of treatment, and except that all machines provide large control for the pilot, there is, in the machines exhibited, little evidence of unanimity of method. Leaving out the difficult problem of the spiral dive and considering the machines for lateral stability in linear motion, the points of interest in the machines rest with the positions of the vertical fins or their equivalents.

The most usual combination of fins, which may be seen on the Blériot, Deperdussin, and Bristol machines amongst others, is a dihedral angle between the wings, constituting an equivalent fin above the centre of gravity, and the side of the covered body together with the rudder, the latter making a fin behind the centre of gravity. In a recent lecture before the Aëronautical Society, the superintendent of the Aircraft Factory pointed out that the effect of dihedral angle is dependent to a greater or less extent on the arrangement for warping the wings, a freely connected cross-warp tending to eliminate the effect of dihedral angle. If for the time being we neglect the complication introduced by the warping mechanism, the system reduces to one of the cases considered by Messrs. Harper and Bryan, who state that, "for stability, the distance of the tail fin behind the centre of gravity must not be less than a certain inferior limit." The condition is closely connected with the covering of the tail girder, as the covering means that the equivalent fin is brought nearer to the centre of gravity of the machine.

The only representative at the exhibition of another method of obtaining lateral stability is the Handley Page monoplane. In common with other well-known machines, such as the Dunne and Etrich, the Handley Page monoplane has wings of special shape and disposition arranged so as to give righting couples to the machine when rolling or turning occurs. The experimental information available is not yet sufficiently advanced to show that this system of specially shaped wings is either better or worse than the more usual one previously referred to, which depends on wings of a simpler form.

Perhaps the best indication of the position of the subject of lateral stability is to be found in the fact that the whole of the warp and rudder is left to the personality of the pilot, and that both are powerful controls. As the periods of the oscillations are comparatively long, it is quite within the bounds of possibility that a pilot would be able to keep his balance without the aid of inherent stability devices. If, however, the treatment of longitudinal stability is any indication of the trend of construction, then in the near future we may expect considerable attention to be paid to the problems of lateral stability, and that the final solution will not be inconsistent with the principles of stability deduced from mathematical investigations of the stability of small oscillations.

THE SCIENTIFIC WORK OF THE LOCAL GOVERNMENT BOARD.[1]

IN the introduction to the report before us Dr. Newsholme surveys the public health of England and Wales during 1911, and reviews the work of the medical department of the Board for the year ending March 31, 1912. The variations in mortality from various diseases since 1901 are illustrated by charts, as in the previous report. The percentage increase of population for 1901–11 remains the same (12·4) as in the preceding decade, but this is due to a fall in the death-rate by 3·0 per cent., which just counterbalances the decline in the birth-rate. The deaths from scarlet fever continued to decline during 1911, those from diphtheria and enteric fever increased slightly, but those from diarrhœal diseases showed a considerable increase over previous years, due to the abnormally hot season; even so, however, there was less diarrhœa, still less infant mortality, in 1911 than in 1899.

The previously plague-infected district in East Anglia has been kept under observation, and during July–October, 1911, 15,332 rats were examined, and twenty-seven farms or other premises were found to harbour plague-infected rodents.

Of the auxiliary scientific investigations carried out for the board, the first is a report on arterial degeneration by Dr. Andrewes. Dr. Newsholme points out in his introductory remarks that while there has been a great reduction in the general death-rate during the past thirty or forty years, this reduction only affects ages up to forty-five years, while higher ages participate in it little or not at all. In fact, for males between fifty-five and seventy-five, the death-rate actually tends to be going up. Inasmuch as one-third of the total deaths for the age period fifty-five to sixty-five is caused by diseases of the heart and blood-vessels, a knowledge of the causation of arterial degeneration is of importance. Dr. Andrewes's report is of a preliminary nature; he considers that the use of tobacco appears at most an adjuvant cause, while the influence of alcohol cannot be satisfactorily demonstrated.

Studies on the frequency of non-lactose fermenting and non-liquefying aërobic bacilli in young children have been continued at Birmingham by Dr. Lewis, and at Liverpool by Dr. Alexander, and Dr. Graham-Smith has investigated the incidence of the same organisms in flies. Prof. Nuttall and Messrs. Strickland and Merriman record observations on the species and number of fleas on British rats.

Prof. Hewlett and Dr. Nankivell have investigated the influence of the Porter-Clark water-softening process on the bacterial content of water treated by it, and find that considerable purification is effected thereby.

Dr. Blaxall finds that 0·1 per cent. of oil of cloves is a valuable aid in the preparation of glycerinated calf lymph free from micro-organisms.

Altogether this volume contains matter of much scientific value and importance. R. T. H.

[1] Forty-first Annual Report of the Local Government Board, 1911–12. Supplement containing the Report of the Medical Officer for 1911–12.

THE MOUNTAINS AND THEIR ROOTS.[1]

(1) IT would be difficult to conceive a greater divergence in character and scope between two books, nominally dealing with cognate subjects, than between the two first-named on our list. Prof. Bonney, in his metaphorical use of the word "building," follows popular usage, for how

[1] (1) "The Building of the Alps." By Prof. T. G. Bonney, F.R.S. Pp. 384. (London: T. Fisher Unwin, 1912.) Price 12s. 6d. net.
(2) Survey of India. Professional Paper No. 12: "On the Origin of the Himalaya Mountains: a Consideration of the Geodetic Evidence." By Colonel S. G. Burrard, F.R.S. Pp. ii+26. (Calcutta, 1912.)
(3) Survey of India. Professional Paper No. 13. "Investigation of the Theory of Isostasy in India." By Major H. L. Crosthwait, R.E. Pp. iii+14. (Dehra Dun, 1912.)

many, when speaking of a building, whether it be cottage or cathedral, ever think of anything but the superstructure, the material or methods of construction, the outward form, or the internal plan? And so Prof. Bonney deals with the Alps. Commencing with the materials of which they are made, he goes on to deal with the processes by which they were raised, and the carving of their outward form by rain, rivers, and glaciers, winding up with the vegetation that clothes their surface, the animals that wander over them, and the humanity which frequents them, whether as permanent inhabitants or temporary visitors. Attractively got up and pleasantly written, it gives Prof. Bonney's views on all these subjects—views which, as he mentions in the preface, are by no means universally accepted, but which, we may add, are none the less deserving of respectful attention—and will prove of interest not merely to the geologist, but to every intelligent and observant traveller in the Alps.

(2) Col. Burrard's memoir is of an entirely different character from Prof. Bonney's book. Addressed to the adept, it makes no appeal to the tyro, and, leaving on one side all consideration of the superstructure, deals only with what may be called the foundations of the Himalayas. Geodesists have long known that the attraction exercised by mountains on the plumb-line is much less than that which should result from their visible masses, and the explanation, first suggested by the late Sir G. Airy, has of late years crystallised itself in the hypothesis of isostasy, according to which the mountains are supported by a species of flotation, the excess of material in the protuberance above sea-level being compensated by a defect of density below.

The most complete and best-known investigation of this hypothesis is that of Mr. J. F. Hayford, of the United States Coast and Geodetic Survey, who has dealt with it, in the light of American geodetic observations, in an elaborate manner. The form of the hypothesis adopted by him was that the compensation extended to a uniform depth, and was effected by variation of the density of the earth's crust, so that the total downward pressure of a column of rock under the mountains should be the same as that of the lesser thickness under the ocean depths. Assuming this as the method of compensation, he found that the residual differences between the observed and the calculated deflection became least if the depth to which the compensation extended was taken at about 113·7 kilometres, and with that assumption the residuals became so small that the hypothesis might be accepted as extremely probable. This is not, however, a necessary conclusion, for an erroneous hypothesis may be in accord with a limited number of observations, but fail when these are extended; and the result of the application of Mr. Hayford's explanation to the Indian observations shows that it is inapplicable to that country.

(3) The facts on which this conclusion is based are interesting, and are given in detail by Major Crosthwait. At stations within the Himalayas the plumb-line is deflected by about 30″ to 40″ to the north, along the foot of the hills this has sunk to some 15″ or thereabouts, and at distances of more than forty miles it disappears or is replaced by a small southerly deflection. There is, consequently, a rapid variation in the amount of the observed deflection as we cross the limits of the mountain range, and this change is about double as great as it should be on Mr. Hayford's hypothesis.

The only other explanation investigated by Col. Burrard is that of foredeep, filled with sediment, and according to his calculations this hypothesis gives results which depart even further from observation than Mr. Hayford's. Col. Burrard offers an explanation of his own—that there is a rift in the subcrust along the foot of the mountains, the gradual opening of which gave rise to the compression of the Himalayas, and which became filled with the alluvium of the Gangetic plains as it was formed. Unfortunately he confesses that he is not geologist enough to elaborate this hypothesis, and it is difficult to see how it can be brought into accord with what is known of the geology of the Himalayas and of the country to the south of them, nor how it differs from Prof. Suess's foredeep.

Moreover, Col. Burrard appears to have overlooked an important paper, published by Rev. O. Fisher in *The Philosophical Magazine* of 1904, in which he investigates the effect of the Himalayas on the plumb-line in the light of an hypothesis of isostasy radically different from Mr. Hayford's. According to this the crust is of uniform density, the isostatic compensation being obtained by a variation in thickness, and on this hypothesis he finds that the attraction of the visible range, combined with the negative attraction of the downward protuberance, should give a northerly deflection of about 24″ at the foot of the hills, of 2″ at sixty miles away, and a southerly deflection of about 2″ at the farther edge of the plains. These results appear to be in very fair accord with observations in the region of the great Gangetic plain of upper India, where the conditions resemble those postulated in the calculations; beyond this region, in the Punjab and in Bengal, the variations are greater than in the central area, but there the conditions are complicated by the fact that geology suggests, and gravitation measurements indicate, the presence of denser rock at a small depth below the alluvium.

It must be acknowledged that Mr. Fisher's investigations do not give a complete explanation of all the variations observed, but this is inevitable in the case of any hypothesis which assumes—as must be done for purposes of calculation—that the crust and the underlying material have everywhere the same density. All that can be said is that it seems to be more closely in accord with the Indian observations than Mr. Hayford's, and it is to be hoped that Col. Burrard will be able to complete his investigations by a study in detail of the relation between the effects which should be observed, according to it, and the actual results of observation.

SIR WILLIAM ARROL.

SIR WILLIAM ARROL, the famous bridge-builder, born in 1839 at Houston, Renfrewshire, died on February 20 at his residence, Seafield House, Ayr. His great mechanical abilities and his remarkable administrative powers—two qualities not often found associated—enabled him in the space of little more than forty years, for he started on his own account only in 1869, to expand a humble little boiler-repairing shop into the great Dalmarnock works employing some 5000 hands.

Sir William Arrol was fortunate in finding a suitable field of work for the mental gifts with which he was so richly endowed. From the first his attention had been directed to the many novel problems, hitherto unsolved, which must be overcome if the building of long-span steel bridges was to be rendered commercially possible. It is with the great steel cantilever bridge over the Firth of Forth that his name will be for ever linked. Designed by Sir John Fowler and Sir Benjamin Baker, the hazardous and difficult task of its erection was entrusted to the firm of W. Arrol and Co. Splendid as was the design, perfect as were the working drawings down to the minutest details, when they left the hands of the two designers, it is not too much to say that it was the mechanical genius of William Arrol which made the erection of the bridge a possibility within the limits of time and cost which had been laid down by the engineers. The lengths of the spans and the height of the piers were far beyond anything previously attempted, and as a result the difficulties which had to be overcome would have daunted most men; they only served to show more clearly the extraordinary gifts he possessed. It was in this task that his mechanical genius found its best outlet. During the whole of the seven years that the work was in progress he was constantly busy, scheming new devices such as improved hydraulic riveting appliances, oil-fired rivet-heaters, complex and ingenious machines for the troublesome task of drilling the plates which went to build up the huge steel compression members, and, most important of all, no detail, however insignificant, escaped his watchful supervision and control.

He received his knighthood on the completion of the bridge in 1890, and never was this honour bestowed on one who had more worthily earned it; he had revolutionised the art of bridge-building and made it a science. The Tay Bridge, the Tower Bridge, and many other great structures will bear testimony to the fact that Sir William Arrol was, as a mechanical engineer, fully entitled to a place in that little band of men whose achievements in the field of engineering shed lustre over the last half of the nineteenth century.

NOTES.

BAD news is to hand from the Australian Antarctic expedition, under the leadership of Dr. Mawson, for two members of it have lost their lives. These are Lieut. Ninnis, an Englishman, and Dr. Mertz, a Swiss member of the scientific staff. The manner of their death is not stated, and, indeed, the whole message, which has reached Australia from the wireless telegraphic station established by the expedition at Macquarie Island, leaves us anxious for further information. It may be recalled that the expedition, reaching the Antarctic region in February of last year, was divided into two parties, under Dr. Mawson and Mr. Wild respectively, which landed about 143° E. and 95° E., in Adélie Land and Kaiser Wilhelm Land. It is known that valuable scientific work has been done, and that a considerable extent of coast-line has been charted for the first time. The vessel of the expedition, the *Aurora*, returned to Australia after landing the parties, and made a second voyage to the south to bring them off. It was thought that Dr. Mawson was aboard her, but apparently he missed her, owing to "unfortunate circumstances," which are not specified, and will have to remain in the south for another year, with six of his staff. For the rest, after mentioning the unhappy loss above referred to, he merely adds that there has been a successful sledging season, "opening up a large area of new land, both east and west of Commonwealth Bay, and obtaining important data at a number of stations in close proximity to the magnetic pole." But in view of what has befallen, anxiety must remain for many months as to the welfare of this party.

IT is officially announced that in recognition of the Antarctic work of her husband, the King has been pleased to grant to Mrs. Kathleen Scott the same rank, style, and precedence as if Capt. Scott had been nominated a Knight Commander of the Bath, as he would have been had he survived.

AN interesting exhibition of works by the late Mr. Thomas Woolner, R.A., is open at his studios, 29 Welbeck Street, W., until March 8. The exhibits include a number of objects of interest to men of science, among them being plaster busts of Charles Darwin, Huxley, and Richard Quain, bronze medallions of Darwin and Sir Joseph Hooker, a colossal head, in plaster, of Capt. Cook, and a bronze medal representing science and research. Any works not disposed of during the exhibition will be sold in the studio by auction, on a date to be announced later.

WE learn from *The Lancet* that, on the suggestion of the High Commissioner for Cyprus, the Secretary of State for the Colonies has arranged that a visit shall be paid to the island, during March, by Sir Ronald Ross, K.C.B., F.R.S.. The object of the visit is to investigate the causes of the prevalence of malarial fever in the island, and to advise in regard to the best means of combating the disease.

THE President of the Board of Agriculture and Fisheries has appointed Mr. D. H. Lane and Mr. Stephen Reynolds to be members of the Departmental

Committee which he has recently appointed to inquire into the present condition of the inshore fisheries, and to advise the Board as to the steps which could with advantage be taken for their preservation and development. The President has also appointed Dr. E. H. J. Schuster to be a member of the advisory committee recently constituted to advise the Board on questions relating to the elucidation through scientific research of problems affecting fisheries.

On Wednesday, March 12, a special meeting of the Faraday Society will be held in the rooms of the Chemical Society, Burlington House, when the programme will consist of a general discussion on the subject of "Colloids and their Viscosity." The chair will be taken by the president, Dr. R. T. Glazebrook, C.B., F.R.S., and papers will be read by Dr. Wolfgang Ostwald, Drs. H. Freundlich and N. Tshzake, Dr. W. Pauli, Dr. V. Henri, Mr. E. Hatschek, Prof. F. G. Donnan, F.R.S., Dr. S. B. Schryver, Prof. W. M. Bayliss, F.R.S., and Mr. W. B. Hardy, F.R.S.

At the annual general meeting of the Physical Society, held on February 14, the officers for the ensuing year were elected as follows:—*President:* Prof. A. Schuster, F.R.S. *Vice-Presidents:* Those who have filled the office of president, together with Mr. F. E. Smith, Prof. C. H. Lees, F.R.S., Prof. T. Mather, F.R.S., Dr. A. Russell. *Secretaries:* Mr. W. R. Cooper, Dr. S. W. J. Smith. *Foreign Secretary:* Prof. S. P. Thompson, F.R.S. *Treasurer:* Mr. W. Duddell, F.R.S. *Librarian:* Dr. S. W. J. Smith. *Other Members of Council:* Prof. C. G. Barkla, F.R.S., Prof. P. V. Bevan, Dr. W. H. Eccles, Prof. J. W. Nicholson, Major W. A. J. O'Meara, C.M.G., Prof. T. C. Porter, the Hon. R. J. Strutt, F.R.S., Dr. W. E. Sumpner, Mr. R. S. Whipple, Dr. R. S. Willows.

At the anniversary meeting of the Geological Society, held on February 21, the officers for the ensuing year were appointed as follows:—*President:* Dr. A. Strahan, F.R.S. *Vice-Presidents:* Prof. E. J. Garwood, Mr. R. D. Oldham, F.R.S., Mr. Clement Reid, F.R.S., and Prof. W. W. Watts, F.R.S. *Secretaries:* Dr. A. Smith Woodward, F.R.S., and Mr. H. H. Thomas. *Foreign Secretary:* Sir Archibald Geikie, K.C.B., President R.S. *Treasurer:* Mr. Bedford McNeill. The following awards of medals and funds were made:—Wollaston medal, Rev. Osmond Fisher; Murchison medal, Mr. George Barrow; Lyell medal, Mr. S. S. Buckman; Bigsby medal, Sir Thomas Henry Holland, K.C.I.E., F.R.S.; Wollaston fund, Mr. W. W. King; Murchison fund, Mr. R. E. L. Dixon; Lyell fund, Mr. Ll. Treacher; Barlow-Jameson fund, Mr. J. B. Scrivenor and Mr. Bernard Smith. The president delivered his anniversary address, which dealt with the form of that part of the Palæozoic platform which underlies the secondary rocks of the south-east of England.

The meetings of the Institution of Naval Architects will be held on March 12–14 inclusive, in the hall of the Royal Society of Arts. The morning meetings begin at 11.30, and the evening meetings on March 13 and 14 at 7.30. On March 12 the election of officers will take place, the president's address will be delivered, and the institution gold medal and premiums presented. Papers will be read and discussed on each of the three days of the meetings, and among the subjects to be considered the following may be mentioned:—The mechanical gearing for the propulsion of ships, by the Hon. Sir Charles A. Parsons, K.C.B.; the energy systems accompanying the motion of bodies through air and water, by Prof. J. B. Henderson; the calculation of stability in non-intact conditions, by Prof. W. S. Abell; notes on modern airship construction, by Baron A. Roenne; and the longitudinal stability of skimmers and hydro-aëroplanes, by Mr. J. E. Steele. The annual dinner will be held on March 12, at 7.30 p.m., in the Grand Hall of the Connaught Rooms.

In connection with the paragraph which recently appeared in our columns on the Pennant collection presented to the Natural History Museum by Lord and Lady Denbigh, it may be mentioned that, according to a notice in *The Times*, the birds include two very interesting specimens of the capercaillie. These, it is inferred, probably represent the old British stock, which became extinct about 1760 in Scotland, and, if so, are its only known representatives. Further examination may prove the right of the British bird to rank as a distinct race. The capercaillies now found in certain parts of Scotland are the descendants of Scandinavian birds introduced about 1837 by the then Marquis of Breadalbane, at Taymouth Castle. In a notice of the collection in *The Pall Mall Gazette* of February 19 it is stated that Mr. Edgar Smith has found that a British snail described by Pennant as *Helix rufescens* turns out to be a young specimen of *H. arbustorum*. For the British species which has hitherto been incorrectly identified with *H. rufescens* the name *H. montana* is available.

The Board of Trade announces with regard to the forthcoming expedition of the *Scotia* (see p. 680), which is being organised jointly by the Board of Trade and the North Atlantic steamship lines for the purpose of ice observation in the North Atlantic, that one member of the staff will be a trained meteorologist. Dr. Assmann, director of the Royal Prussian Aëronautical Observatory at Lindenberg, has made a valuable contribution to the scientific equipment of the *Scotia* by providing a number of kites for meteorological work, and instruments to be attached to these kites for recording air pressure, temperature, relative humidity, and wind velocity. It is hoped that if the weather conditions on the voyage are favourable a considerable addition may be made to the present very meagre knowledge as to the conditions of the currents in the upper air in the regions off the east coast of Newfoundland and Labrador. The long-range wireless apparatus in the vessel is being provided free of charge by the Marconi Company. Two wireless operators will be employed in order that a constant watch may be kept.

The keen north-easterly wind which blew with such persistence over the British Isles for the eight days from February 15 to February 22 has checked somewhat the early and rapid development of vegetation, and in this way it will have proved beneficial. The cold over the United Kingdom was, however, by no means great, and the maximum day temperature at Greenwich was only below 40° on two days, February 18 and 20, although in the ten days from February 13 to February 22 there was only one day, February 16, with the shade temperature above 43°. The frost at night was generally slight, but on the early morning of February 23, when the north-east wind had practically ceased, the shade temperature at Greenwich fell to 24°, which is the lowest reading since February 6, 1912, and the exposed thermometer on the grass fell to 10°. The weather was generally very dry. The controlling factors were a region of high barometer, mostly to the north of Scotland, and areas of low barometer to the south of Europe. On the Continent, and especially in France and Germany, the weather for the period was much colder than in the United Kingdom. Snow fell at Nice on February 17 and 19, and on February 17 the maximum day temperature at Nice was 41°, whilst at Greenwich for the same day the maximum was 42°.

At the annual general meeting of the Royal Astronomical Society on February 14, Dr. F. W. Dyson, the president, gave an address on the presentation of the gold medal which had been awarded to M. Henri Alexandre Deslandres, for his investigations of solar phenomena and other spectroscopic work. He pointed out that M. Deslandre's labours in solar physics have extended over more than twenty-one years. His researches on banded spectra established the laws followed by all spectra of this class; he also investigated the spectrum of the corona and of comets and their tails. But his most important work was with the spectroheliograph and a velocity recorder devised by himself, with which, perhaps, even more important results are being obtained. The chief general conclusion drawn from the velocity records is that the bright areas on the solar surface are descending and the dark filaments ascending. He has always kept in mind the ultimate object of his researches—the determination of the constitution and circulation of the solar atmosphere. The gold medal was handed to M. Roux, secretary of the French Embassy, for transmission to M. Deslandres, who was unable to be present. The president also announced that the Jackson-Gwilt bronze medal and gift had been awarded to the Rev. T. H. E. C. Espin, for his observations of the spectra of stars and his discovery of Nova Lacertæ. After a brief account of these researches, the president handed the medal and gift to Mr. Espin.

News has reached us, by cablegram from Calcutta, of the death, on February 19, of Prof. W. Tate, professor of chemistry in the Civil Engineering College, Sibpur. Prof. Tate received his early scientific education at the Midland Institute, Birmingham, whence he proceeded, in 1886, to the Royal College of Science, South Kensington, as a national scholar. After a brilliant career as a student, he obtained the associateship of the college in chemistry, with honours, in 1889. He was then appointed demonstrator in one of the chemical laboratories of the college, and during that period he was engaged in some researches, and prepared a revised and enlarged edition of Sir Edward Thorpe's "Chemical Problems." About sixteen years ago Prof. Tate was appointed to the Indian Educational Service as professor of chemistry at the Civil Engineering College at Sibpur, which is situated in rather an unhealthy and somewhat malarious locality five or six miles to the south of Calcutta, on the banks of the Hooghly; and he continued in this appointment up to the time of his death. He had to reorganise, and almost to create, the chemical department of that college. Under his supervision a very successful and commodious laboratory was erected and equipped, and excellent work has been done in it by the students under his tuition. He also gave great help to committees of the Calcutta University in determining the courses in science for its degrees in civil engineering and also in other University questions. He did valuable work during the whole of his service in India, and was very popular with the members of his department, and also with his students. His death at a comparatively early age will be deeply regretted by many friends, both in India and at home.

The exhibition of "Wonders of Science," held in the Surbiton Assembly Rooms on February 19–22, proved remarkably successful, the capacity of the hall being frequently inadequate to accommodate all seeking admission. It is estimated that more than 7000 persons attended during the hours for which the exhibition was officially open; in addition, about 1200 school children were admitted in the mornings. The official programme mentions 152 exhibits, but many of these consisted of numerous objects. They included scientific apparatus, instruments, records, and specimens, illustrating the progress of science, particularly in physics, electricity, chemistry, botany, astronomy, and medicine. In many instances instruments were shown in actual working. Demonstrations were given, from time to time, on liquid air, wireless telegraphy and telephony (including the transmission of music), the culture of bacteria, science applied to music, glass-blowing, the use of the potter's wheel, the Fleuss life-saving apparatus, &c. A party of boys who had made themselves experts in blowing soap-bubbles was always the centre of a group of interested spectators, whilst the fascination of motion drew others to the gyroscope tops, rainbow cups, mercury heart, vortex rings, and the paper circular saw which was cutting wood. Microscopic objects shown under about forty microscopes had a constant succession of interested observers. The electric light produced by induction, as shown by Mr. Sharman, attracted great attention, as did also the Röntgen rays, the radium exhibit, the Pathéscope, and the optophone, an instrument by which light rays produce audible vibrations. The great success of the exhibition may be attributed to (1) the generosity of many prominent men of science in lending exhibits and assisting in other ways; (2) the energy and zeal of a large party of local workers, aided by friends from a distance, under the leadership and direction of the president, the Rev. J. C. Harris; (3) the satisfactory efforts of the publicity and tickets committees to advertise the exhibition beforehand in the district.

Lord Carnarvon and Mr. C. L. Woolley have recently been excavating Beacon Hill, in Hampshire, and the results are communicated by the latter to the January issue of *Man*. The fine contour-fort supplied examples of two types of construction, large circles, possibly pens surrounded by wattle enclosures, and hut dwellings sunk down to the chalk. The former contained a fragment of black pottery of the Bronze age. A mile or so from Beacon Hill is the group of tumuli known as the "Seven Barrows." In one of these, which had not previously been disturbed, were found several burnt flints, which in the absence of human bones suggest disposal of the dead by cremation, as was usual in southern England. The form of the barrow is its most interesting feature, the open stone ring recalling the external structure of the long barrows, and suggesting that this constitutes an intermediate link between the long and round types of barrow.

To the January number of the New York Zoological Society's Bulletin Prof. H. F. Osborn communicates an illustrated account of the remarkably fine series of wild horses, asses, and zebras at present living in the menagerie, where a new house has recently been built for their reception. The paper is accompanied by a couple of maps showing the distribution of the various species and races.

According to an article by Mr. E. R. Waite in the fourth number of Records of the Canterbury (N.Z.) Museum, that institution has acquired, at a cost of 400*l*., the skeleton of a Sibbald's rorqual, prepared from an individual stranded near Okarito, on the west coast of the south island. In the flesh this monster measured 87 ft. in length. The museum has also added to its collection a cast and the skeleton of a stranded specimen of Layard's beaked whale.

We have received from Mr. J. A. Hutton, of Woodlands, Alderley Edge, a table showing the annual number of salmon taken in the Wye from 1905 to 1912, with nets and with rods, and also the number of tons of "fish" taken, year by year, from 1890 to 1912. In the first table the "record" occurred in 1912, when the total number of salmon was 6205, with a collective weight of 91,068½ lb., while in the second the maximum catch, by Miller's netting, was 60¼ tons.

In the February issue of *British Birds*, the editor records that a swallow ringed in Staffordshire in May, 1911, was taken near Utrecht, Natal, on December 23, 1912. After commenting on the length of the journey made by this bird, Mr. Witherby expresses the opinion that the evidence at present available does not support the view that British swallows normally travel southwards by the East African route, as might be inferred to be the case from the new record.

Some months ago we recorded the arrival at Mr. Carl Hagenbeck's establishment of five specimens of the pigmy West African hippopotamus, these, which were sold to Berlin and New York, being the first living examples of their kind to reach Europe. As announced in *The Times* of February 7, an immature living specimen has been received at the Zoological Gardens in Regent's Park. A descriptive illustrated account of the animal, which has been conditionally purchased by the society, is given by Mr. Pocock in *The Field* of February 15.

That the mysterious humming in the air heard at times in fine summer weather in this country is due (as recorded in Nature in November last) to chironomid flies, is fully endorsed in a note communicated to the February number of *The Entomologist's Monthly Magazine* by Dr. E. E. Green. Writing from Ceylon, Dr. Green states that when bicycling by the border of a lake he heard a loud noise, which he had first attributed to machinery in motion, but that soon after he ran into a dense fog of minute flies, from which the sound proceeds. These flies, which sometimes swarm into the houses of the residents in such numbers that they may be swept up in the morning by the bushel, are, it seems, a species of Chironomus. Dr. Green also endorses the opinion that the sound is produced by a true stridulating action.

Prof. A. H. Trow has during the last six years made a study of the inheritance of certain characters in the common groundsel (*Senecio vulgaris*), and has published some of his results in *The Journal of Genetics*, vol. ii., No. 3. He finds that this is an aggregate species which includes many segregate or elementary species, of which he has cultivated twelve; these were maintained pure and true to type for at least several generations. Six of them have been studied in detail, and are distinguished by more or less descriptive names; the others are for the present simply designated with their place of origin, all except one being British. The investigation has included the critical examination of about 10,000 groundsel plants; the most exacting work, consisting of long and tedious series of measurements of the vegetative organs, will form the basis of a further paper by the author.

Under the title, "World Weather Bureau Favoured," *The Pittsburg Post* (Pa.) of January 27 contains the report of a statement by Mr. H. H. Clayton, for many years meteorologist at the late Prof. Rotch's observatory at Blue Hill (Mass.), with reference to the importance of the establishment of a central international weather bureau, where the accumulating observations from all parts of the world could be discussed. The idea of such an institution was mooted many years ago, and Mr. Clayton thinks its want is growing greater; he remarks: "It is ever becoming more apparent that if we are to leap the bounds of day-to-day forecasts for the seasons we must collect observations and study the meteorology of the world as a whole." And with reference to crops and their connection with droughts and rainfall he points out that fabulous sums are at stake. Bearing upon the latter subject we may also refer to an interesting lecture, "Meteorology and Agriculture," especially the section on the possibilities of the use of statistics, delivered by Dr. W. N. Shaw at Cambridge, and printed in the Journal of the Scottish Meteorological Society (vol. xvi., No. xxix.) Mr. Clayton pays a well-merited tribute to the "splendid pioneer work" of Rotch, Teisserenc de Bort, Hildebrandsson, and of Sir Norman and Dr. Lockyer, but he points out that an organisation on a very large scale is required, employing meteorologists from all over the world, cooperating with all Government institutions, yet having an individual existence and a permanent endowment.

In his second Cantor lecture before the Royal Society of Arts, on the methods of economising heat, Mr. C. R. Darling referred to the great saving which might be effected if engineers would devote more attention to the physical laws and methods of heat insulation. Data are now available which enable the heat losses in the case of furnaces, and the heat gains in the case of refrigerating plant, to be reduced materially. The two problems must be kept distinct, as the materials which may be best at one temperature are seldom the best at another temperature, owing to the great change of heat-insulating properties of substances with temperature.

The National Electric Lamp Association of Cleveland, Ohio, has just published No. 1 of an Abstract Bulletin which contains abstracts of all the scientific papers issued from the physical laboratory of the association from its inception in 1908 to the present time. The full papers are already available in the proceedings of scientific societies or in the technical Press, but the abstracts of twenty-eight papers which the present number of the bulletin contains will be of great use to those who require the results of the investigations without the experimental details. We have had occasion to refer to some of these results, and we only propose here to direct attention to the wide ground covered by the abstracts, which are all prepared by the authors themselves. Several of them deal with the selective radiation from incandescent metals, many with photometry of lights of the same or different colours, a number with the efficiencies of lamps, and several with visual acuity. The association is to be congratulated on the scientific value of the work which is turned out from its physical laboratory.

Notices have recently appeared in the daily Press and *The Scientific American* regarding an invention by M. Moreau, of Paris, which, according to the accounts, is claimed to be a solution of the problem of automatic stability for aëroplanes. The main feature would appear to be that the aviator sits in a kind of swing, described as a pendulum seat, operating on the rudder for vertical steering, although it is stated that the seat can also be fixed by means of a brake. This arrangement may facilitate personal control, and in this respect, experience may prove it to be successful, but it can scarcely be likely to secure "stability." Suspension of the aviator's seat is statically equivalent to raising the centre ot gravity of the system, while, on the other hand, any pendulum arrangement increases the number of possible oscillations and adds to the difficulty of satisfying the conditions of stability. So little has been done in applying the principles of rigid dyanmics to aëroplanes that any attempt of this kind must be regarded as highly doubtful from a theoretical point of view. At the present time even Newton's laws of motion are quite disregarded in many writings and experiments on aviation. The "ideal pendulum," which is supposed to maintain a fixed direction without oscillating, has no more existence than the perfectly smooth body of our text-books. Failing an efficient study of the dynamics of the problem, the safest course in experimenting with pendulums is to damp their oscillations as much as possible. Perhaps the aviator himself damps the oscillations, in which case this may be a practical and successful way out of the difficulties.

No. 1 of vol. v. of the Journal of the College of Agriculture, Tokyo, contains a number of exceptionally interesting papers. Prof. U. Suzuki and S. Matsunaga show that nicotinic acid occurs together with oryzenin in rice bran; this observation is of special interest, as, apparently, it is the first time that nicotinic acid has been observed in plant material, although a homologue, picolinecarboxylic acid was isolated by Schreiner and Shorey some years back from soils rich in humus. Mr. T. Yabuta has studied a new organic acid which is formed by the action of *Aspergillus oryzae* on steamed rice in the manufacture of "koji," and to which the name "koji-acid" is given; it is not identical with any acid yet obtained from the lower fungi, and is apparently also formed by some other Aspergillus species, but not by Penicillium or Mucor. There is an interesting paper by Mr. S. Muramatsu on the preparation of "natto," a vegetable cheese obtained by fermenting boiled soya beans, and the nature of the micro-organisms involved in the change, whilst Mr. R. Inouye contributes an important study of the chemical composition of the silkworm at different stages of its metamorphosis.

The Builder for February 21 refers to the announcement that Prof. Boni has found that three large lifts were in operation at the Imperial Palace on the Palatine Hill in ancient Rome. Modern refinements of mechanism and finish were lacking, but the fact tha machinery of this kind was employed affords additional evidence of the engineering genius of the Romans. Roman houses were heated in the first century by means of hot air proceeding from furnace-rooms and circulating under floors and inside the walls. Excavations in Pompeii have brought to light a house with well-designed hot and cold water service on a plan closely resembling modern installations. Instances such as these emphasise the point that modern achievements depend upon improved appliances and increased scientific knowledge rather than upon superior intellectual capacity.

Mr. J. D. Potter has published separately, at the price of 2*s*. 6*d*. net, the "New Log and Versine Altitude Tables," from "The 'Newest' Navigation Altitude and Azimuth Tables for Facilitating the Determ[illegible]tion of Lines of Position and Geographical Position at Sea," by Lieut. R. de Aquino, the second edition of which was reviewed in NATURE for February [illegible] last (vol. xc., p. 617).

THE proceedings at the conference on the theory of radiation, held in Brussels in 1911, have been referred to in two articles in NATURE. The first appeared on November 16, 1911 (vol. lxxxviii., p. 82), and the second on January 16, 1913 (vol. xc., p. 545). We have now received a copy of a volume containing the papers read at the conference and reports of the discussions upon them; it is printed in French, edited by MM. P. Langevin and M. de Broglie, and published by M. Gauthier-Villars, of Paris, at the price of 15 francs.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR MARCH:—

March 2. 0h. 24m. Jupiter in conjunction with the Moon (Jupiter 5° 22′ N.).
3. 22h. 50m. Uranus in conjunction with the Moon (Uranus 4° 2′ N.).
4. 8h. 30m. Mars in conjunction with the Moon (Mars 3° 19′ N.).
9. 2h. 53m. Mercury in conjunction with the Moon (Mercury 1° 29′ N.).
11. 8h. 30m. Venus in conjunction with the Moon (Venus 2° 1′ N.).
13. 12h. 36m. Saturn in conjunction with the Moon (Saturn 6° 23′ S.).
17. 8h. 43m. Neptune in conjunction with the Moon (Neptune 5° 34′ S.).
19. 3h. 0m. Venus at greatest brilliancy.
20. 17h. 18m. Sun enters Sign of Aries, Spring commences.
21. 23h. 58m. Moon eclipsed, invisible at Greenwich.
29. 14h. 29m. Jupiter in conjunction with the Moon (Jupiter 5° 19′ N.).

THE SOLAR ACTIVITY.—A sun-spot of unusually high latitude is at present visible on the solar disc. First seen on February 19, when it had just come over the eastern limb in heliographic latitude about 35° N., the spot has since developed somewhat, and on Monday last the leading nucleus was fairly large and dense. An outbreak in such a high latitude possibly marks the beginning of a new sun-spot cycle, for the new cycles generally commence at a great distance from the equator, while the old cycle is dying away near the equator.

As pointed out in Monday's *Times*, the epoch of the next maximum of spot activity is somewhat uncertain because the previous maximum, 1906, was late, and presented a double peak.

PHOTOGRAPHIC MAGNITUDES OF STARS IN COMA BERENICES.—On five plates taken with a 4-in. anastigmat portrait lens, Herr Hnatek has measured the extra-focal images of 104 stars in the asterism Coma Berenices, and publishes the results in No. 4629 of the *Astronomische Nachrichten*. In addition to the definitive mean magnitudes, ranging from 5·2 to 10·3, Herr Hnatek gives the magnitudes as determined from each of his five plates, the B.D. number, the spectral type (Harvard), and the differences between his own and five other measures by various observers; these comparisons show differences varying with magnitude and spectral type. For example, it is seen that the difference of magnitude Hnatek-Pickering increases as the temperatures decrease, and amounts to 0·43 mag. for class K stars.

THE DISTRIBUTION OF SPECTROSCOPIC BINARY STARS. —From Prof. Stroobant we have received an abstract from the *Comptes rendus* (vol. clvi., p. 37), in which he has discussed the distribution of spectroscopic binaries, as compared with other stars, in the celestial sphere. Dividing the sphere into 20° zones of galactic latitude, he finds that of the 306 stars given in Campbell's second catalogue of spectroscopic binaries, 217 lie within the zone +30° to −30° galactic latitude, and only eighty-nine without it. For naked-eye stars generally, the proportion is 3154 to 2565, according to Houzeau.

This preponderance near the Milky Way is found to be due to the relatively large number of helium stars among the binaries, about 35 per cent. of the total, for, according to Pickering, 93 per cent. of 686 helium stars are to be found in the galactic zone.

HIGH-LEVEL MEASUREMENT OF SOLAR RADIATION.— In No. 1, vol. xxxvii., of *The Astrophysical Journal* Prof. Very discusses the conditions affecting the measures of solar radiation at high levels. Taking measures made up to nearly 30 km., he shows that aqueous vapour, the chief atmospheric absorbent of solar radiations, is still present, in appreciable quantities, at these great altitudes; thus the limits of the aqueous atmosphere are extended much further than some meteorologists have thought to be possible. Having reduced observations made at sea-level, 4420 and 13,700 metres, he finds thermal equivalents, at these heights, of 1·5, 2·00, and 2·86 cal./sq. cm. min. respectively, and by plotting these results gets a value for the solar constant of radiation of 3·5 cal./sq. cm. min.

THE BLEACHING OF FLOUR.[1]

EARLIER reports to the Local Government Board on the chemical changes produced in flour by bleaching, which have been summarised already in these columns, have been written with the object of producing chemical evidence of the supposed injurious effect of bleaching. A recent legal decision of considerable moment has stated that the presence of 3·43 parts of nitrites per million does not alter the genuineness of flour, and that it is admitted that no injurious effects from such a quantity of nitrites can be proved. The result of commercial bleaching is merely to alter the colour of flour to suit the taste of the consumer without altering the nature, substance, and quality of the flour so as to render it a different article.

In the present report, Dr. Monier-Williams admits evidence which brings his views more into line with those prevailing elsewhere.

Following the suggestion of Wesener and Teller, the colouring matter of flour has been compared by him with carrotene, the yellow plastid colouring matter of plants which is so obvious in the carrot. The method of comparison adopted is a physical one, namely the examination of the absorption spectra of the two pigments, which are shown to be identical. The colouring matter of flour is thus established as carrotene.

Pure carrotene crystallises in small leaflets of an intense red colour, which, on exposure to the air, gradually absorb oxygen and form a colourless compound. Carrotene also absorbs practically its own weight of nitrogen peroxide, forming colourless compounds of unknown nature, which, however, all give

[1] Report to the Local Government Board by Dr. G. W. Monier Williams. Food Reports, No. 19. October, 1912. Price 3d.

the colour test for nitrites. It is thus clear that the two processes of bleaching carrotene, namely either by oxygen or by nitrogen peroxide, are quite distinct. It is assumed that the same holds good in flour and that artificially bleached flour, in which normally about one-third of the colouring matter has been destroyed by bleaching, and naturally aged flour are not quite the same thing.

It is shown by Dr. Monier-Williams that unbleached flour, stored in small bags, as is customary in the retail trade, gradually loses its colouring matter, and at the same time picks up nitrites, which in time may amount to 1·4 parts of $NaNO_2$ per million. This is much the same quantity as is present in the freshly milled bleached flour typical of the London mills,[2] which, although it loses further colouring matter on storage, does not absorb any more nitrite. Actually after two months' storage bleached and unbleached flours are practically identical. Samples of very heavily bleached flours had altered after two years' keeping, so that they then only contained about as much nitrite as ordinary unbleached flours kept for a few months.

The interesting conclusion is drawn that under ordinary conditions of storage there is an approximate figure towards which the nitrite content of all samples, whether highly bleached or unbleached, will eventually converge.

With the cooperation of Mr. Kirkland, Dr. Monier-Williams has tested the baking qualities of some heavily bleached flours. Mr. Kirkland reports that all the loaves were of excellent quality, and had no remarkable taste or smell. The one exception—flour containing 100 times the usual quantity of nitrite—gave a loaf which did not rise so well and possessed a somewhat rancid, oily taste.

Leaving any ethical considerations as to the propriety of bleaching flour entirely out of account, this report serves to establish conclusively that there is no scientific evidence that bleaching by means of traces of nitrites is injurious, and it is now proved that the presence of traces of nitrites in stored flour is a natural course of events.

REEVES'S NIGHT MARCHING WATCH.

MESSRS. C. F. CASELLA AND CO., LTD., have submitted a "night marching watch," designed by Mr. E. A. Reeves, and costing 2*l*. 15*s*. This is an ingenious device intended to help travellers to know their bearings when moving at night, provided that they are able to recognise the brighter stars. The stars made use of are Aldebaran, Rigel, Sirius, Procyon, Regulus, Denebola, Spica, Arcturus, Antares, Altair, Fomalhaut, Capella, and, of course, by day the sun. The positions of these, together with the days of the months, are printed on a ring outside the watch face, but under the watch glass, and capable of being turned by the bezel (which unfortunately is smooth instead of being milled) so as to bring the date against the hour XII. Then the hour on the watch face under any star's position when multiplied by two is the time measured from noon to this star's meridian passage. A rectangular mark of luminous radium paint carried on the star rim is then set to this doubled time, and the watch is ready for use with that star.

The hour hand carries a luminous projection which rides over the edge of the star rim, and as this hand rotates in the watch twice as fast as the earth rotates or the star appears to go round, the angle between the two luminous marks already described as subtended at the centre of the watch, is double the hour angle of the star. But the angle at the centre is double the angle subtended by the same arc at a point on the circumference, and therefore these two marks will subtend the star's hour angle at any point on the circumference on the other side of the watch. A luminous arrow-head is therefore placed upon the edge of the glass, which is capable of being turned round without turning the bezel. When the arrow mark is removed from the other two, and the watch face is inclined roughly to the colatitude with the first-named luminous mark at the upper side, and then turned in azimuth until a line passing through the arrow and the other mark is directed towards the star, then the first luminous mark as seen from the arrow will be in a southerly direction.

As is usual with astronomical things, there are certain cases where the rules have to be turned inside out (as, for instance, when a star crosses the meridian to the north), and these are explained in the pamphlet. Unfortunately this pamphlet is ambiguously worded, and anyone not understanding the principle would have great difficulty in finding out what to do. The question which must occur to anyone at all familiar with the night sky is this: Has not ingenuity been misplaced? Even if the pole star be not visible, there is very little doubt, at least in the northern hemisphere, where it is. In the southern hemisphere, it is true, there is a great blank in the polar region, but it does not take long to learn the relations of the conspicuous southern stars to the pole. While therefore some people might like to use the watch and enjoy the use of it on account of its ingenuity, others might prefer in practice to do without.

THE VEGETATION OF THE TRANSCASPIAN LOWLANDS.

DR. O. PAULSEN has published an English edition, revised and corrected by Dr. W. G. Smith, of Edinburgh, of his important memoir on "The Vegetation of the Transcaspian Lowlands." This memoir forms the first part of the biological section of the botanical results of the second Danish Pamir expedition—the systematic part of the botanical results having been already published as the examination of the various natural orders was completed—and contains 279 pages, with 79 illustrations, and a map of the area studied. After describing the situation and boundary of the region examined, together with the general geological and climatic characters of Transcaspia, the author deals in considerable detail with the vegetation, which he classifies under the headings of five distinct plant-formations. These formations are the riverside thickets (bushland) and four types of desert formation (salt, clay, sand, and stone deserts).

The second half of the memoir is devoted to an extremely interesting account of the various biological types of growth forms. The author follows Raunkiaer's system according to which the plants are arranged in classes depending upon the way in which they live through unfavourable seasons, special emphasis being laid on the degree and kind of protection afforded to the dormant shoot-tips. Of the 768 species listed, nearly half are annuals which live through the hot, dry summer as seeds, having flowered during the rainy period; trees and shrubs are few and small, chiefly tamarisks, Calligonum (Polygonaceæ), and shrubby Papilionaceæ (especially Astragalus); the Compositæ of the Transcaspian flora include 103

[2] In other districts where a very white flour is required a stronger bleach is often adopted.

species: Chenopodiaceæ 94, Papilionaceæ 85, Cruciferæ 51, Gramineæ 44, Boraginaceæ 42. Interesting comparisons are drawn between the Transcaspian flora and the floras of various other regions, desert and otherwise, with reference to the proportional representation of the families and also of the biological types. The memoir concludes with detailed notes on the structure and biological adaptations of various Transcaspian species investigated by the author.

F. C.

THE "AËROSCOPE" KINEMATOGRAPH HAND CAMERA.

AN interesting demonstration of the greatly extended adaptability of kinematographic apparatus was given by Mr. Kasimir Proszynski at a meeting of the Royal Photographic Society on Tuesday, February 18. In introducing the "Aëroscope" hand camera, the lecturer made some general remarks dealing with the problem of flicker, the presence of which, more or less pronounced, has been of considerable trouble to producers of moving pictures. He stated that up to the present time it had been generally understood that the suppression of flicker was in some manner due to the phenomenon of persistence of vision, which, according to the experiments of Helmholtz and other investigators, continues about one-seventh of a second after the light impression has ceased.

Mr. Proszynski considers this idea a mistaken one, and by means of a series of diagrams and demonstrations with the lantern he made out a strong case for his view that flicker is due to the slightly varying lengths of time during which the light from each picture is transmitted to the screen through the openings in the sector shutter. If the opaque portions of the shutter are not all exactly equal, the eye, being extremely sensitive to slight *variations* of illumination, receives the impression of alternating light and darkness corresponding to the difference between the angular size of the blades of the shutter sectors. From this point of view the flicker should be completely eliminated by using any simple shutter with four, three, or even two wings, the essential feature being that the wings must all be very accurately made of the same size. Various forms were shown in the lantern projector; in practice the three-bladed sector shutter is found most suitable.

Another feature embodied in the "Aëroscope" camera is its adaptability for use without a tripod stand, thereby greatly extending the scope of its usefulness to the portraying of scenes quite inaccessible to the ordinary camera requiring a steady support. The camera is fitted with self-contained mechanism for driving the film, consisting of a small air motor, driven by compressed air stored in four steel reservoirs held in the camera body. These cylinders can be recharged by means of a cycle pump to a pressure of 400 lb. per sq. in. The motor is fitted with a governor for keeping the motion of the mechanism uniform, and a lever control on the exhaust for securing different values of this motion to suit different subjects.

The chances of injurious vibration during the exposure of the film are very neatly minimised by the introduction of a heavy gyrostat wheel in the end of the camera box; this is also driven from the air motor.

A series of beautiful pictures of scenery, including animals and moving water, taken by Mr. Cherry Kearton in North America, was sufficiently convincing as to the efficiency of this novel method of animated picture photography.

C. P. B.

THE NATIONAL PHYSICAL LABORATORY.

WITH the view of raising funds to complete the additions now in progress at the laboratory, the executive committee of the laboratory last autumn appointed a funds committee, with Sir W. H. White as chairman, and entrusted it with the task of appealing for support to persons interested in their national work.

This work was commenced at Teddington in the year 1901; the great need of an institution such as the laboratory and the importance of its work have been amply demonstrated by its rapid growth. The original buildings comprised Bushy House, granted by the Crown, and an additional building for the engineering department. The wide scope of the work at the present time will be sufficiently indicated by an enumeration of the various buildings, and a brief indication of the purposes for which they are intended.

(1) Bushy House, providing accommodation for administration offices and for divisions dealing with electrical units and standards, general electrical measurements, thermometry, optics, and tide-prediction.

(2) Engineering building, for general engineering research and tests, with additional accommodation for aëronautical investigation, and for the examination of road materials (Road Board Laboratory).

(3) Metallurgy building, for investigations into the properties of metals and alloys.

(4) Electrotechnics building, equipped for researches connected with electricity, and for the testing of alternating- and direct-current instruments of all kinds, as well as of material for electrical purposes; also for photometric work, especially the standardisation of sources of light.

(5) Metrology building, for measurements of length, end gauges, cylindrical gauges, screw gauges, tapes and wires for survey work, &c., the standardisation of weights, and the testing of measures of area and volume, glass vessels, &c.

(6) William Froude National Tank, for experiments on models of ships.

(7) Observatory Department. This section of the work has been housed at Kew Observatory, and includes the testing of thermometers, optical instruments such as telescopes, binoculars, sextants, theodolites, &c., watches, chronometers, and many other types of instruments.

To provide for the research work which is continuously in progress, and occupies perhaps two-thirds of the time of the scientific staff, generous assistance has been afforded by many private individuals, by the City companies, and by all the great technical institutions, some of which have made annual grants for this purpose for many years past.

Some three years ago it was evident that further buildings were needed at Teddington. The accommodation for the metallurgical work was then quite inadequate, while the office and administration rooms were entirely unsuited to their purposes. The library had long overflowed the small room allotted for its use ten years ago. The arrangements for the receipt and dispatch of goods remained much as at the beginning, and it had become increasingly difficult to deal with the apparatus and material sent for test.

Moreover, the optical and thermometric test work at Kew has quite outgrown the opportunities for test at the old observatory, and modern demands require a revision of the methods and appliances available for the work. In addition, a scheme has been approved by the Royal Society and the Government for setting free the observatory for meteorological observations and research by the removal of the test work to Teddington. The Office of Works has arranged to make certain alterations at Kew for this purpose, while the laboratory committee provides the necessary accommodation for tests.

Accordingly a scheme of new buildings at Teddington was prepared at an estimated cost of about 30,000*l*., or, if scientific equipment is included, 35,000*l*. Towards this the Lords Commissioners of H.M. Treasury agreed to contribute 15,000*l*. in three instalments if the scheme could be completed without further application to the Government. Thus, it was left to the committee to raise, for the buildings alone, about 15,000*l*.

This sum has now been obtained; the metallurgy building, erected through the generosity of the late Sir Julius Wernher, is complete and occupied, but much additional equipment is required. The other buildings are in course of erection, and funds are urgently needed towards their equipment. The minimum estimate for this is 5000*l*., of which about 3000*l*. has been contributed. Thus, apart from the special equipment for metallurgy, at least 2000*l*. more is needed to complete the scheme, and it is for this that support is being asked.

The following are the present members of the committee: Sir William H. White, K.C.B., F.R.S. (chairman), Lord Rayleigh, O.M., F.R.S., Sir A. B. Kempe (treasurer R.S.), Prof. A. Schuster (secretary R.S.), Mr. J. A. F. Aspinall, Sir J. Wolfe Barry, K.C.B., F.R.S., Dr. G. T. Beilby, F.R.S., Sir Hugh Bell, Bart., Dr. Horace T. Brown, F.R.S., Colonel Crompton, R.E., C.B., Mr. J. M. Gledhill, Mr. R. Kaye Gray, Sir R. A. Hadfield, F.R.S., Mr. D. Howard, Sir J. Larmor, M.P., F.R.S., Dr. W. H. Maw, Mr. R. L. Mond, Sir A. Noble, Bart., K.C.B., F.R.S., Hon. Sir C. A. Parsons, K.C.B., F.R.S., Sir Boverton Redwood, Bart., Mr. Alex. Siemens, Mr. T. Tyrer, and Prof. W. C. Unwin, F.R.S.

PROGRESS IN AGRICULTURAL EDUCATION.

THE Board of Agriculture and Fisheries has issued its annual report on the distribution of grants for agricultural education and research in the year 1911–12 (Cd. 6601). Bound up with the report are statements respecting the several colleges aided, and a summary of the agricultural instruction provided by county councils in 1910–11.

The classes and courses of instruction which the Board of Agriculture and Fisheries aids are those intended for persons of sixteen years of age or more, who have finished their school education, and are either pursuing technical studies with the view of becoming agriculturists, or are already engaged in agriculture and desire to improve their knowledge of the subject. The list of grants awarded in aid of educational institutions in the year 1911–12 shows that the total amount of the grant was 18,840*l*., the same as in 1910–11. The interim grants in aid of agricultural research paid by the Board from the Development Fund during 1911–12 amounted to 9263*l*., and the special grants for experiments and research to 250*l*.

The accounts sent to the Board by local education authorities show that they are spending in round figures 80,000*l*. per annum on agricultural education. The Board's grants for work in universities and colleges, not included in this sum, would bring the total public expenditure on agricultural education, apart from the Development Fund, to about 90,000*l*. per annum.

We reprint below a part of Prof. T. H. Middleton's introduction to the report, referring to research institutes for agriculture:—

The State has now placed, for the first time, a large sum for research at the disposal of British agriculture, and it is clearly the duty both of the central and local authorities to devise means for applying to practical farming the knowledge provided by workers in research institutes. The purpose of the grants made for research is not in this instance to subsidise scientific workers, but to develop agriculture by scientific means, and until the knowledge of the laboratory has been translated into practice in the field the work is incomplete. When reconsidering their educational methods, local education authorities should understand that their aid is expected in securing from the expenditure and labour incurred in agricultural research results of real value. The research institutes endowed by the Development Fund are national, not local institutions. The primary duty of the persons engaged in these institutes is to advance knowledge, and the needs of local agriculture, if they are considered at all, can only be considered incidentally. The result is that if any locality wishes to make use of the research institutes it must take steps to adapt scientific discoveries to its own conditions.

It should further be remembered by those responsible for the education of agriculturists that not only are the results of the work of all the new research institutes to be available for agriculturists in any county, but as a consequence of the establishment of research institutes in England this country may now draw upon the results obtained by the investigators of all other countries in a way that was formerly impossible. There has thus been created a system for bringing within reach of English agriculture the knowledge resulting from the vast amount of work now undertaken in the research laboratories of all civilised countries. But all this knowledge will be valueless to any particular locality until it has been applied by farmers to the cultivation of their land. How is this application of scientific discoveries to the commercial questions of the ordinary farm to be accomplished? Can farmers be expected to study scientific treatises? If farmers did study and understand the publications of research stations, could they afford the time and the cost involved by the adaptation of the applications of new principles to the particular circumstances of their own farms?

If answers to such questions as the foregoing are attempted it will be agreed that the Development and Road Improvement Funds Acts have added new responsibility to the work of local education authorities, or at least that a duty which was formerly inconsiderable has now become important. The only important task of a local committee charged with agricultural education has hitherto been to provide for the instruction of young persons up to the time when they leave school or college, or to supply itinerant teachers capable, as a rule, of instructing novices only; they are now expected to make the provision required for advising experienced farmers on the means to be adopted in applying scientific discoveries to practice—a difficult and responsible task.

It is sometimes contended that the only satisfactory way of applying science to agriculture is to give the young farmer a sound scientific training, and leave him to apply the discoveries of scientific men which come before him in his later years. This, it is assumed, he can do for himself after he has gained experience. The usefulness of a proper early training cannot be questioned, and the work of the research institutes will make its usefulness even greater in future, but however good the early training of the farmer may be, it will not enable him to make full use of the work of research institutes unless he has scientific advisers to guide him. Agricultural science has made such progress in recent years and its departments have become so specialised that the acquaintance which a lad may make with it at school or college would no more enable him to dispense with scientific guidance in after-life than a course in veterinary hygiene would enable him to dispense with the veterinary surgeon, or a course in agricultural law would enable him to conduct his own law business. The indifferent success which experimenting agriculturists meet with has been a subject of remark for two centuries at least by farmers who must pay rents; but the reason for the ill-success has not been so clearly recognised as in the corresponding case of the man who is his own lawyer.

It is further a mistake to suppose that the proper way to introduce the results of scientific research to farmers is to spread information by means of lectures or leaflets. Information can be spread by these means, but not, as a rule, the results of research as first published by the research institute. Few of the discoveries made by research workers are likely to be immediately applicable to the farm practice of a particular district. Modifications in a well-established art clearly require skilful handling, and when it is desired to utilise the results of research, cooperation between skilful farmers and trained scientific men should therefore be aimed at. When on a particular farm the success of the new method has been established as a result of this cooperation, neighbours will learn by imitation, and the improvement may with advantage be brought to the notice of others by lectures and leaflets.

In view, then, of the provision now made by the State for research, of the importance of securing for each county the fullest benefit from results available for all, and of the need for caution in introducing new methods, local education authorities should consider the nature and qualifications of the local staff required. For spreading a knowledge of practices which have been shown to be improved practices, instructors with a good practical knowledge of some branch of agriculture are wanted. The number at present available is small, but the requirements are already known and well defined. Local education authorities need experience no great difficulty in securing suitable men for this particular type of work after the supply has had time to adjust itself to the demand. The position as regards the farmer's scientific advisers is, however, different, and for the most part the types have still to be evolved. For the purpose of translating the results of research into successful practice a highly trained scientific man is required having a special knowledge of some particular branch of science and a sufficient acquaintance with agriculture to command the respect of skilful and enlightened practical farmers. Many branches of science bear on agriculture, the research scheme contemplates institutes in eleven subjects, and most of these subjects would provide a field of work for several specialists. It is clear, therefore, that no county could afford to maintain all the specialists who might usefully be engaged in assisting farmers to apply research. For the present all that is practicable is to lay the foundations of a system having as its object the bringing into existence of a class of well-qualified specialists who shall devote themselves to the service of agriculture. The first essential is that the specialists to be employed should really be specialists; "all-round" men would be of no use for the particular purpose in view. The second essential is that the persons who are to be engaged in the work of promoting agriculture should be of the same calibre as those who have advanced arts like medicine and engineering.

It is obvious from the qualifications required in the men to be employed, that the only practicable way of securing their services will be for groups of counties to associate themselves with collegiate institutions providing laboratories and other facilities for scientific workers, and it is with the object of facilitating combination and of initiating the system of employing specialists recommended above that the Board's advisory scheme was drafted.

Having regard to the institutions available as centres, the Board arranged the counties of England and Wales in twelve groups or "provinces," and it has obtained a grant of 12,000*l.* per annum from the Development Fund, which will be employed in providing certain trained specialists in each area. The grants are made to the governors of the collegiate centres, who, subject to the approval of the Board, select the officers and are responsible for their work. The teaching staffs of most of the institutions selected are already doing some advisory work, and the officers first selected under the new scheme will be chosen with the view of supplementing the work of the staff already in existence. As the work expands, it is expected that additional advisers will be added to the staff.

While these grants are made to the governors of central institutions it should be clearly understood that their object is to place skilled scientific advice at the disposal of farmers resident in the different groups of counties, and in framing their schemes of work local education authorities will be expected to make provision for securing to residents in their administrative areas the benefits of the provision made by the colleges. In particular, local instructors should be directed to apply to the college in all cases in which the assistance of an expert is desirable.

It will be apparent that while the new system is in its early stages many of the questions submitted to institutions may be on subjects other than those on which the advisers have expert knowlege; in such case the advisers would in the first place consult their colleagues on the college staff, and if the necessary advice is not obtainable they would then consult advisers at other institutions. By linking the collegiate centres together in this way it is intended that a farmer in any particular county should be able, through the centre with which his county is associated, to get the best expert advice on any agricultural question.

A further shortcoming inevitable in the working of a new scheme may be noticed. Since no class of agricultural specialist, corresponding to the medical specialist, exists, it will be necessary to train up men for the work, and therefore to employ at the outset young and inexperienced persons. For the first few years the work must suffer from this lack of experience, but just as well-trained young medical men quickly acquire experience, so will these specialists who are being trained to help agriculturists.

It may be convenient in conclusion to give a list of the groups of workers who will in future be provided for the purpose of aiding the farmer to increase the productiveness of land.

Group I. Scientific workers engaged in research—the extension of knowledge in national research institutes devoted to the study of different sections of agricultural science without reference to the needs of particular localities.

Group II.—Scientific workers engaged in consultative work with a view to the application of the results of research to practice. These workers will be stationed at collegiate centres serving groups of counties; as distinguished from workers in Group I. they will make a special study of the needs of particular localities.

Group III.—Teachers engaged in the diffusion of knowledge; of these the following subgroups may be distinguished:—

(*a*) Lecturers in universities and colleges instructing pupils whose age, previous education, and circumstances enable them to attend college courses.

(*b*) Teachers employed at farm schools in instructing pupils who for various reasons would not benefit from, or could not attend, college courses.

(*c*) Instructors employed in peripatetic work teaching those who, because of their age and circumstances, cannot study in schools or colleges.

The work of persons employed in the different groups may overlap. The worker in a research institute may often be asked for advice, a college teacher may frequently be called upon to give extension lectures, and at certain seasons of the year the peripatetic instructor may be required to teach in a farm school; but in the main the work of the different groups is distinct, and now that increased funds are available it is to be hoped that the authorities responsible for selecting those employed under agricultural education schemes will recognise more fully than heretofore the need for a division of labour. The "all-round" agricultural expert is no longer much required, except for the general supervision of local work; to be really useful either to the large farmer or the small-holder the teacher must be a specialist; if he is a scientific man his attainments in some branch of science should be high; if a practical man he must be a more skilful practitioner than the majority of those whom he instructs.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

London.—Mr. T. Ll. Humberstone has been appointed to the Mitchell studentship. The studentship, which is of the value of 100*l*., is awarded to the selected candidate to enable him to study and investigate some definite feature of business or industrial organisation at home or abroad. Mr. Humberstone proposes to investigate a scheme of industrial fellowships in the Universities of Pittsburg and Kansas, under which research work in applied science is promoted with funds provided by, and to some extent under the supervision of, great industrial and commercial organisations.

Applications are invited for the newly established Franks studentship in archæology, founded by the Society of Antiquaries in London, in memory of Sir A. Wollaston Franks, K.C.B., sometime president of the society. The object of the studentship is to enable the student to carry on some research or preparation for research (as distinct from professional training) in the archæology of the British Isles in its comparative aspects. The studentship is of the value of 50*l*., and is tenable for one year. Applications should reach the academic registrar not later than March 5.

Oxford.—Prof. Lloyd Morgan, F.R.S., has been appointed Herbert Spencer lecturer for 1913.

By the will of the late Lord Ilkeston, the sum of 800*l*. is bequeathed to the warden, bursar, or other proper officer of the University of Durham upon trust to apply the income for a "Winifred Foster Scholarship" for a woman student who requires help to maintain herself at the University.

A very well illustrated prospectus of Bingley Training College has been received. The college owes its existence to the public spirit of the County Council of the West Riding of Yorkshire, and was opened for the reception of students in October, 1911. It provides accommodation for 200 resident women students, and includes a central educational block, five halls of residence, gymnasium, kitchen, bakery, and laundry. The purpose of the college is to train teachers for public elementary schools, and the training provided is such as to fit the students for their work as teachers. No provision is made for students wishing to take a course leading to a university degree.

The Berlin correspondent of *The Morning Post* states, in the issue for February 24, that plans for transforming the scientific institutes at Frankfort-on-Main into a university have now been sanctioned by the Prussian Ministry of Public Instruction. In May, 1912, the Emperor commissioned the Ministry to submit to him the draft of the statutes as soon as it was satisfied that the necessary funds for the establishment and endowment of a university were in hand. Ample funds are at the disposal of the city of Frankfort for the purpose, and the drawing up of the statutes is now merely a matter of form. The capital required and subscribed for the scheme is nearly 400,000*l*. The existing institutes will be enlarged and a medical institute created. It is doubtful whether the university can be opened, as anticipated, in October, 1914. The new university will devote special attention to social science.

It is announced in *Science* that Ohio-Miami Medical College of the University of Cincinnati has received 25,000*l*. from a donor whose name is being withheld. An effort is being made to raise an endowment fund of 200,000*l*. From the same source we learn that during the past year three wills, involving property valued at 25,000*l*., have been proved in favour of Knox College. About half of this amount becomes available immediately for the endowment of a professorship in one of the departments of science, while the remainder is held in trust during the lifetime of the widow of one of the testators. Mr. Eugene Meyer and his wife, of New York, have given Cornell University 2000*l*. to endow a fellowship in memory of their son, Edgar J. Meyer, who graduated from Sibley College, and whose life was lost by the sinking of the *Titanic*. The purpose of the fellowship is to encourage research in mechanical and electrical engineering.

A Reuter message from Delhi announces that an important State paper on the educational policy of India was issued officially there on February 21. It begins by quoting the King's speech at Calcutta University and the promises of Imperial grants for education. The needs of every grade and department of educational work are reviewed, and the paper goes on to state that India urgently needs to be equipped with an ethnographic museum. It lays special stress on the formation of character through direct instruction, and indirect agencies such as the betterment of environment, hygiene, physical culture, and organised recreation. It invites local governments to appoint expert committees to ensure satisfactory school and college hygiene. In reviewing university education, the paper contemplates facilitating grants in aid, and frames rules distinguishing the Federal and the affiliating university. The policy is to multiply universities, having one affiliating university for each leading province and developing teaching faculties and research at a university centre, while establishing teaching and residential universities at Dacca, Benares, Aligarh, and elsewhere as the need arises. Special attention is given to the education of the domiciled community and Mahomedans, the training of teachers, and the establishment of an Oriental Research Institute on Western lines. It foreshadows a large increase of the inspectorate and teaching staff, and indicates the need of better prospects for the educational services and of having expert guidance at every turn. The paper recommends also that primary and secondary education should be more practical, and that provision should be made in India for higher education and research.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 20.—Sir Archibald Geikie, K.C.B., president, in the chair.—Prof. H. E. **Armstrong**, M. S. **Benjamin**, and E. **Horton**: Studies on enzyme action. XIX., Urease: a selective enzyme. II., Observations on accelerative and inhibitive agents.—Prof. C. S. **Sherrington**: Nervous rhythm arising from rivalry between antagonistic reflexes; reflex stepping as outcome of double reciprocal innervation. The paper is in continuation of work on the reciprocal innervation of symmetrical muscles—work recently communicated to the society. The observations have been almost wholly upon the decerebrate preparation. The symmetrical muscles used in the present experiments have been the extensors of the right and left knee. It is shown that taking an afferent nerve which produces steady reflex excitation of the muscle, and another which produces steady reflex inhibition of the muscle, it is possible by stimulating both nerves concurrently to obtain regularly rhythmic contractions and relaxations of the two muscles, the rhythm being about 2 per second.—Dr. H. E. **Roaf**: The liberation of ions and the oxygen tension of tissues during activity (preliminary communication). The combination Ag | AgCl | Muscle | Ringer-Solution | HgCl | Hg shows an increased negative charge on the silver when the muscle contracts. The combination Pt | MnO_2 | Muscle | Ringer Solution | HgCl | Hg shows an increased positive charge on the platinum when the muscle contracts. This result must be due to an increase in hydrogen ions. The combination Pt | Muscle | Ringer Solution | HgCl | Hg can be used as an indicator of the oxygen tension in contracting muscle.—W. **Cramer** and J. **Lochhead**: Contributions to the biochemistry of growth. The glycogen content of the liver of rats bearing malignant new growths. Glycogen disappears more rapidly from the liver of tumour-bearing rats than from the liver of a normal rat.—Prof. T. G. **Brodie** and J. J. **Mackenzie**: Changes in the glomeruli and tubules of the kidney accompanying activity.

Geological Society, February 5.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—Dr. A. M. **Davies** and J. **Pringle**: Two deep borings at Calvert Station (North Buckinghamshire), and the Palæozoic floor north of the Thames. The two borings are about 370 yards apart in a due east-and-west direction. The eastern boring gives the following section:—

Altitude of Surface = about 200 *O.D.*

	Thickness ft.	in.
Soil	4	0
Oxford Clay—Ornatum Zone ...	93	3
Non-sequence.		
Forest Marble	38	9
Non-sequence.		
Great Oolite	59	6
Non-sequence.		
Chipping Norton Limestones ...	7	6
Non-sequence.		
Lias—Domerian, Algovianum Zone to Charmouthian, Jamesoni Zone	240	6
Unconformity.		
Lower Tremadoc—Shineton Shales	954	6
	1398	0

R. W. **Hooley**: The skeleton of *Ornithodesmus latidens*, an Ornithosaur from the Wealden Shales of Atherfield (Isle of Wight). The bones were obtained from blocks recovered from the sea after being washed from a huge fall of the Wealden Shales. Portions of the skeleton missing in the Atherfield specimens are supplemented by bones in the British Museum (Natural History), No. R. 176, upon which the late Prof. H. G. Seeley founded the genus. There are remarkable peculiarities in the skull which isolate it from all known families. The wonderful preservation of the bones enables the mechanism of the skull, joints, and movements of the limbs to be described. The paper deals with the morphology, and institutes comparisons with other types. The evidence proves that it is necessary to form a new family, and that Ornithodesmus has descended from a suborder which should include Scaphognathus and Dimorphodon.

Physical Society, February 14.—Prof. A. Schuster, F.R.S., president, in the chair.—Prof. G. H. **Bryan**: The dynamics of pianoforte touch. The author discussed Helmholtz's and Kaufmann's theories of the vibrations of a pianoforte wire excited by impact, with special reference to the effects obtainable with the modern pneumatical piano-players and player-pianos, and the common widespread belief that these can never reproduce the touch of the human fingers.

Royal Meteorological Society, February 19.—Mr. C. J. P. Cave, president, in the chair.—W. H. **Robinson**: Periodical variations of the velocity of the wind at Oxford. The author dealt with the annual and diurnal changes in the velocity of the wind as recorded at the Radcliffe Observatory during the last fifty years. The average monthly values show that there is a rapid fall in the velocity of the wind between March and June, and an equally rapid rise between September and December. The minimum is in September. There is a range in the annual variation of three or four miles per hour. On comparing the wind velocity with the mean monthly temperatures of the air the author finds that an increase (or decrease) of one mile per hour in the velocity of the wind corresponds to a fall (or rise) in the temperature of about 8° F. As regards the diurnal oscillations, the wind increases its velocity with an accession of warmth, and decreases with a lowering temperature, this being the inverse of that found in the discussion of the annual variation.—J. S. **Dines**: Rate of ascent of pilot balloons. The author described some experiments which he had made in the large airship shed at the Royal Aircraft Factory, Farnborough, with the view of determining the rate of ascent of small pilot balloons of the type which he has used for the past two years in his work for the Advisory Committee for Aëronautics.—W. L. **Balls**: Meteorological conditions in a field crop. The author described the methods which he had adopted for ascertaining the temperature, the humidity, and the force of the wind on the surface of the soil in a field of cotton at Giza. The growth of the cotton plant in Egypt is usually completely arrested by sunshine during the greater part of the day, through the severe water loss necessitated by thermo-regulation of the internal temperature, and growth, during most of the season, is thus confined to the hours of darkness. The usual limiting factor of this growth during the night is the temperature of the tissues—roughly, the air temperature, with slight modification by clouds; thus any cause making for a rise in temperature at night involves a higher growth-rate in consequence; this in its turn, in the early part of the season at least, implies more rapid development of the flowering branches, bringing about earlier appearance and more rapid accumulation of the flowers, and hence of the crop.

Edinburgh.

Royal Society, February 3.—Prof. Hudson Beare, vice-president, in the chair.—J. S. **Anderson** and G. B. **Burnside**: A new method of starting mercury-vapour apparatus. The vacuum tube was so arranged that liquid mercury filled the region which was subsequently to be filled with the incandescent vapour. By an ingenious device the current as it passed by the platinum into the interior of the tube heated the lower end, expanding the mercury upwards past a narrow constriction in the tube. The mercury column became broken at this constriction, and at once a small arc light through the mercury vapour was formed. This rapidly grew, pushing the liquid mercury to the other end of the tube. The resistance of the circuit being thereby greatly increased, the heating effect in the small outside coil was correspondingly diminished, and thus automatically the lamp was its own temperature regulator. Important details were given as to the method of making the apparatus.—J. **McWhan**: The electron theory of thermoelectricity. This was an application of thermodynamic principles to the electron theory of thermoelectricity, the assumption being that from each metal at all temperatures electrons evaporate producing a definite electron pressure in the neighbourhood. Expressions for the Thomson effect and for the thermoelectric power were obtained.—N. P. **Campbell**: The application of Manley's differential densimeter to the study of sea waters on board ship. The differential densimeter was described in 1907 (see Nature, vol. lxxvi., p 311), and its use explained. Briefly described, it is a modification of Hare's method for comparing densities of liquids. As originally constructed it was not found very convenient for use on board ship. In the present paper certain modifications are described, and results are given showing that it can be used effectively at sea. The density of each sample of sea water may be determined with ease and accuracy at the time it is collected. One great merit is that since the sample being studied is balanced against a standard solution of known density at the same temperature, and since the temperature correction is the same for both solutions, there is no necessity for applying this temperature correction.

Paris.

Academy of Sciences, February 17.—M. F. Guyon in the chair.—G. **Bigourdan**: Observations of nebulæ made at the Paris Observatory.—Paul **Appell**: The equilibrium of wires the elements of which attract or repel each other as a function of the distance.—L. **Lecornu**: The cause of a boiler explosion. A discussion of the causes of the explosion of a boiler forming part of a hot-water system in a private house.—L. **Maquenne** and E. **Demoussy**: The value of the chlorophyll coefficients and their relations with true respiratory coefficients. The results of a long series of experiments are summarised in eleven conclusions, stress being laid on the variation in the respiratory coefficient of leaves with the stage of growth.—M. **Gouy**: The production of intense magnetic fields at the surface of the sun. A discussion of the possibility of the views currently held regarding the production of intense magnetic fields in sun-spots.—W. **Kilian** and Ch. **Pussenot**: New data relating to the tectonic in the neighbourhood of Briançon.—J. **Violle**: The inconvenience which might be caused to telegraphs and telephones in the neighbourhood of certain special lightning conductors called *niagaras*. Report of a committee on lightning conductors. It is recommended that no receiving station or telegraph line should be nearer than 20 metres to this special form of lightning conductor.—M. **Vuillemin** was elected a correspondant for the section of botany in the place of the late M. Strasburger.—Maurice **Gevrey**: The nature of the solutions of certain partial differential equations.—A. **Pchéborski**: Some polynomials with minimum deviations from zero within a given interval.—M. **Valiron**: Integral functions of order zero.—Carl **Störmer**: A mechanical problem and its applications to cosmic physics. The results of a theorem on the trajectories of electrified corpuscles in the field of an elementary magnet. Amongst the applications mentioned as possible are the theory of the aurora borealis of Arrhenius, and the experiments of Birkeland bearing on the zodiacal light, comets, and Saturn's rings.—U. **Cisotti**: The rigid movements of the surface of a vortex.—A. **Grumbach**: The retardation of electrolysis with a polarising electromotive force.—Georges **Meslin**: The reciprocal influence of parallel antennæ on the conditions of reception of Hertzian waves.—André **Blondel**: The bipolar diagram of synchronised alternators working as generators or receivers on a network a constant potential.—G. **Reboul**: The influence of the geometric form of solids on the chemical actions which they undergo. When a solid is acted on by a gas the attack is most active at the points where the curvature is greatest.—Jean **Bielecki** and Victor **Henri**: A quantitative study of the absorption of the ultra-violet rays by fatty acids and their esters in aqueous and alcoholic solutions. In a body of the formula $C_nH_{2n+1}CO_2R$ the absorption is determined by the acid group, the alkyl group having slight influence.—A. **Sénéchal**: The violet chromium sulphates. A study of the water contents of the crystallised salt in various degrees of hydration.—J. **Bougault**: Phenyl-α-oxycrotonic acid. P. **Lebeau** and A. **Damiens**: The estimation of acetylene and ethylene hydrocarbons in mixtures of gaseous hydrocarbons. An alkaline solution of the double iodide of mercury and potassium is suggested as absorbent for gases of the acetylene type; for ethylene, concentrated sulphuric acid containing 1 per cent. of vanadic acid is shown to be a satisfactory reagent.—Pierre **Lesage**: The curve of the limits of germination of seeds after remaining in saline solutions.—R. de **Litardière**: The variations of volume of the nucleus and the cell in some ferns during the heterotypical prophase.—G. **André**: The migration of the mineral elements and the displacement of these elements in leaves immersed in water.—R. **Fosse**: The formation of urea by the higher plants.—M. **Tcherning**: A theory of vision. Jacques **Mawas**: The asymmetry of the ciliary body and its importance in astigmatic accommodation and movements of the crystalline lens.—Jules **Courmont** and A. **Rochaix**: Immunisation against *Staphylococcus pyogenes aureus* by way of the intestine. The introduction of the dead organisms into the intestine confers a certain degree of immunity, and the infection is profoundly modified in its characters.—Casimir **Cépède**: The Cytopleurosporea.—Venceslas **Moycho**: Study of the action of the ultra-violet rays on the ear of the rabbit.—M. **Deprat**: The Palæozoic strata of the Black River (Tonkin).—Maurice **Lugeon**: A new mode of fluvial erosion.

BOOKS RECEIVED.

Anatomical Model of the Mare. (London: Vinton and Co., Ltd.) 2*s*. 6*d*. net.

Streifzüge an der Riviera. By Prof. E. Strasburger. Dritte Auflage. Pp. xxvi+582. (Jena: G. Fischer.) 10 marks.

New Log and Versine Altitude Tables. By Lieut. R. de Aquino. Pp. v*+36*. (London: J. D. Potter.) 2*s*. 6*d*. net.

Siebente Versammlung der internationalen Kommission für wissenschaftliche Luftschiffahrt in Wien

28 Mai bis 1 Juni, 1912. Sitzungsberichte und Vorträge. Pp. v+172. (Vienna: K. K. Hof und Staatsdruckerie.)

Transport de Force: Calculs Techniques et Économiques des Lignes de Transport et de Distribution d'Énergie Électrique. By C. Le Roy. Deux. Partie. Pp. 143. (Paris: A. Hermann et Fils.) 6 francs.

Aborigines of South America. By the late Col. G. E. Church. Edited by Sir C. R. Markham. Pp. xxiv+314. (London: Chapman and Hall, Ltd.) 10*s*. 6*d*. net.

Calendario della Basilica Pontificia del Santissimo Rosario in Valle di Pompei per l'Anno 1913. (Valle di Pompei: Scuola Tipografica Pontificia.)

Canada. Department of Mines. Mines Branch. Report of the Building and Ornamental Stones of Canada. Vol. i. By W. A. Parks. Pp. xiii+376+vi+lxxvii plates. (Ottawa: Government Printing Bureau.)

Transactions of the Institution of Engineers and Shipbuilders in Scotland. Fifty-sixth Session, 1912–13. Part iv. Pp. 109+diagrams. (Glasgow.)

A Treatise on Hydromechanics. By A. S. Ramsay. Part ii., Hydrodynamics. Pp. xiii+360. (London: G. Bell and Sons, Ltd.)

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 27.

ROYAL SOCIETY, at 4.30.—The Thermal Properties of Carbonic Acid at Low Temperatures: C. F. Jenkin and D. R. Pye.—Re-reductions of Dover Tidal Observations, 1883–1884, etc.: E. Roberts.—The Formation of the Anthocyan Pigments of Plants. Part IV. The Chromogens: Prof. F. Keeble, E. F. Armstrong, and W. N. Jones.—The Formation of the Anthocyan Pigments of Plants. Part V. The Chromogens of White Flowers: W. N. Jones.—The Changes in the Breathing and the Blood at Various High Altitudes: Mabel P. Fitzgerald.

CONCRETE INSTITUTE, at 7.30.—Economy in Reinforced Concrete Design: J. A. Davenport.

SOCIETY OF DYERS AND COLOURISTS, at 8.—Starch and Decomposition Products: Dr. M. Hamburg.—A Method for the Testing of Malt Extracts: R. J. May.—The Valuation of Malt Products: W. P. Dreaper.—A Contribution to the Methods of Testing Malt Extracts: Dr. A. Herz.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Fourth Kelvin Lecture—The Ohm, the Ampere, the Volt. A Memory of Fifty Years (1862–1912): Dr. R. T. Glazebrook.

FRIDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 9.—Active Nitrogen: Hon. R. J. Strutt.

PHYSICAL SOCIETY, at 5.—Interference by Röntgen Radiation: Prof. C. G. Barkla and G. H. Martyn.—Alternating-current Magnets: Prof. E. Wilson.—A Graphical Method of Optical Imagery: W. R. Bower.

SATURDAY, MARCH 1.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

MONDAY, MARCH 3.

SOCIETY OF ENGINEERS, at 7.30.—Presidential Address: A. Valon.

ARISTOTELIAN SOCIETY, at 8.—Does Consciousness "Evolve"?: Prof. L. P. Jacks.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Notes on Chinese Antimony Ores, Crude and Regulus: W. R. Schoeller.—Notes on Thermometry: J. H. Coste.

VICTORIA INSTITUTE, at 4.30.—Pompei: E. J. Sewell.

ROYAL SOCIETY OF ARTS, at 8.—Cantor Lecture: Coal Gas as a Fuel for Domestic Purposes: F. W. Goodenough.

TUESDAY, MARCH 4.

ROYAL INSTITUTION, at 3.—The Stars and their Movements: Prof. H. H. Turner.

RÖNTGEN SOCIETY, at 8.15.—The Physiological Effects of the Magnetic Field: Dr. H. Lewis Jones.—The Rationale of the Static Current: Dr. H. Humphris.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—A Saxon Graveyard at East Shefford, Berks: H. Peake and Dr. E. A. Hooton.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—IX. A New Genus of Ichthyotaeniids: Dr. F. E. Beddard.—Zoological Results of the Third Tanganyika Expedition conducted by Dr. W. A. Cunnington, 1904–1905. Report on the Branchiura: Dr. W. A. Cunnington.—New Species of Rhopalocera from Costa Rica: W. Schaus.—Notes on Plankton collected across the Mouth of the St. Croix River opposite to the Biological Station at St. Andrews, New Brunswick, in July and August, 1912: Dr. A. Willey.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Notes on City Passenger-Transportation in the United States: G. D. Snyder.

WEDNESDAY, MARCH 5.

GEOLOGICAL SOCIETY, at 8.—The "Kelloway Rock" of Scarborough: S. S. Buckman.—Jurassic Ammonites from Jebel Zoghuan (Tunis): L. F. Spath.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Accurate Determination of Carbon Dioxide in Carbonates: F. S. Sinnatt.—Egyptian Butter and Semna: S. H. Trimen.—The Bacterial Testing of Disinfectants: A Practical Criticism: C. T. Kingzett and R. C. Woodcock.—A Quick and Improved Method for the Estimation of Boric Acid in Milk and Cream: F. W. Richardson and W. K. Walton.—The Moisture in some English, Colonial, and Foreign Butters during 1910–1912, with a Note on the Mitchell-Walker Moisture Test: L. Gowing-Scopes.

ROYAL SOCIETY OF ARTS, at 8.—Ordinary Meeting—The Development of Research Work in Forest Products: E. R. Burdon.

THURSDAY, MARCH 6.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: An Automatic Method for the Investigation of the Velocity of Transmission of Excitation in Mimosa: Prof. J. C. Bose.—The Evolution of the Cretaceous Asteroidea: W. K. Spencer.—A Preliminary Note on the Fossil Plants of the Mount Potts Beds, New Zealand, collected by Mr. D. G. Lillie, Biologist to Capt. Scott's Antarctic Expedition in the *Terra Nova* in 1911: Dr. E. A. Newell Arber.—(1) Trypanosomes found in the Blood of Wild Animals Living in the Sleeping Sickness Area, Nyasaland; (2) Trypanosome Diseases of Domestic Animals in Nyasaland. II. Trypanosoma Capræ (Kleine); (3) Morphology of Various Strains of the Trypanosome causing Dieases in Man in Nyasaland. I. The Human Strain: Surg.-Gen. Sir D. Bruce, F.R.S., Majors D. Harvey, A. E. Hamerton, and Lady Bruce.

ROYAL INSTITUTION, at 3.—Surface Energy: W. B. Hardy.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Recent Developments in the Street Lighting of Manchester: S. L. Pearce and H. A. Ratcliff.

ROYAL SOCIETY OF ARTS, at 4.30.—Indian Section—The City of Karachi: J. F. Brunton.

FRIDAY, MARCH 7.

ROYAL INSTITUTION, at 9.—Photography of the Paths of Particles Ejected from Atoms: C. T. R. Wilson.

SATURDAY, MARCH 8.

ROYAL INSTITUTION, at 3.—The Properties and Constitution of the Atom: Sir J. J. Thomson, O.M.

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