THURSDAY, AUGUST 11, 1910.

RECENT EARTHQUAKE INVESTIGATIONS.

The California Earthquake of April 18, 1906. Report of the State Earthquake Investigation Committee (in two vols. and atlas). Vol. ii., The Mechanics of the Earthquake. By Harry F. Reid. Pp. viii + 192. (Washington: Carnegie Institution, 1910.)

ON the average a little earthquake occurs in the world every fifteen minutes. Great earthquakes occur on the average about every four days, but it is only on rare occasions that they hit populated districts. The majority of the latter originate beneath deep oceans or in uninhabited mountain regions, and as neither little fish nor wandering tribes write letters to the *Times*, all we know about their occurrence comes from the observations of enthusiastic seismologists. Nineteen hundred and six, however, was a bad year for humanity, and exhibitions of seismic relief took place in many districts. On January 31 a great disaster occurred in Colombia. On April 4 many soldiers and natives lost their lives in the Kangra Valley. On April 14 nearly 6000 houses fell in Formosa, whilst four days later San Francisco and other towns in Central California were reduced to ruins. On June 14, Kingston, in Jamaica, was badly shattered, and in the autumn, on August 17, Valparaiso and Santiago fell. In connection with the disaster at San Francisco, British shareholders in insurance companies were called upon for twelve million pounds, whilst towards the reconstruction in Kingston their contribution was two millions. What they paid for the happenings in other parts of the world I do not know, but it is quite certain that attention was directed to the fact that even the inhabitants of the British islands were not entirely beyond the pale of the vagaries of Mater Terra.

In 1906 the proprietors of newspapers, lawyers, expert witnesses, the vendors of building materials, constructors, and others may have regarded earthquakes as blessings in disguise. The charitably disposed had frequently opportunities to derive comfort from their donations, while scientific bodies saw opportunity for investigations. The International Seismological Association spent a very large sum in collecting and reproducing seismograms relating to the earth movements which had devastated Central Chile. The Carnegie Institution of Washington not only carried on similar work for the earthquake of California, but by publishing three volumes based on the material collected it has considerably extended our knowledge connected with seismological observations.

the first two of these volumes, issued as part i. and part ii., reference has been made already (NATURE, March 4, 1909, vol. lxxx., p. 10). The second volume, by Prof. H. F. Reid, of the Johns Hopkins University, which is now before us, treats of "The Mechanics of the Earthquake." In the discussion on the origin of the shock, this is shown to have taken place from point to point along a line of fracture many miles in length and with a variable depth. There are therefore many times of origin, each of which depends upon the particular point considered. This may be a seismometrical refinement, but Prof. Reid, by his insistence on this, has done much towards the exact understanding of certain observations. In the discussion on permanent displacements of the ground we are shown that as the results of three surveys, the first of which commenced in 1851, there have been permanent displacements parallel to the length of a well-known fault. The ground on the east side of this fault has moved southwards, whilst that on the opposite side of it has gone to the north. A part of this displacement, no doubt, took place at the time of the earthquake, but there are convincing reasons for the belief that much of it took place gradually before the earthquake. The ground, in fact, was bent before it broke. By experiments with a stiff slab of jelly across which a slight cut made by a knife represented a line of fault, the nature of the strain which takes place before and after an earthquake is illustrated. The actual forces required to produce in solid rock the observed distortions, which resulted in rupture, are given in mechanical units. If the depth of the fault was 12·5 miles, its length 270 miles, and the average movement 13 feet, then the work done at the time of rupture is estimated at 13×10^{16} foot-pounds. After this energy was set free, seismographs throughout the world were set in motion.

A cause for the deforming forces which resulted in these strains is sought for in the theory of isostacy, which implies that the shifting of materials accompanying surface denudation is compensated for by a sub-surface flow. By this flow a dragging force is exerted upon the superincumbent crust, which from time to time yields suddenly. To predict tectonic earthquakes we should build a line of piers at right angles to a fault line and determine from time to time the difference in direction between these piers and their relative levels. Such observations, whether they did or did not prove of value as an assistance towards earthquake prediction, it is extremely likely that they would throw light upon certain branches of earth physics. Rotary movements are considered at some length, and the idea that they may be the result of vibrations at right angles is considered to be the one offering the simplest explanation.

A chapter of great interest, not only to the builder, but to the mathematician, relates to the influence of a foundation upon apparent intensity, this being most pronounced upon alluvium.

Part ii. of this volume is devoted to a critical description of seismograms obtained from stations in various parts of the world. This is followed by old and new explanations for the apparent increase in the duration of an earthquake as it travels. This is another good chapter, but it might easily have been extended. The discussion of the velocities with which different wave types were propagated and the paths they may have followed has been worked out with great care, and is distinctly instructive. The determination of the distance of the origin of an earthquake, as is now well known, depends upon the interval of time between the arrival of the first motion and the arrival of

some other phase of motion like the large waves. This is closely examined, and observations previously made upon this point are brought more closely in accord.

Disturbances of magnetic needles at the time of the earthquake have not been overlooked. Much is said in favour of damping pendulums, and reference is made to the recently devised "dead-beat" instruments of Prince Galitzin. We have not, however, come across any reference to his method of determining the direction of an earthquake from the first of the preliminary tremors. The monograph closes with the theory of the seismograph. In this we notice the statement that the instruments designed by myself in 1892 and Dr. Schlütter about 1903, to show tilting of the ground at the time of an earthquake failed to show such a phenomenon. This is only true for the latter instrument (see British Association Report, 1893, p. 222).

Prof. Reid's memoir is a valuable contribution to the mechanics of earthquakes. He has ploughed both new ground and old, and seismologists will thank him for the material he has furnished for their consideration.

JOHN MILNE.

TAR, ACID, AND ALKALI.

(1) *Coal Tar and Ammonia.* By Prof. George Lunge. Fourth and enlarged edition. Part i., pp. xix+563; part ii., pp. xiii+564–1178. (London: Gurney and Jackson, 1909.) Price 42*s.* net, two vols.

(2) *The Manufacture of Sulphuric Acid and Alkali, with the Collateral Branches: a Theoretical and Practical Treatise.* Third edition, enlarged. By Prof. George Lunge. Vol. ii., part i., Sulphate of Soda, Hydrochloric Acid, Leblanc Soda, pp. xx+490; vol. ii., part ii., ditto, pp. xii+491–1010. (London: Gurney and Jackson, 1909.) Price 42*s.* net, two parts.

THESE three terms—tar, acid, and alkali—stand for the most important of the determining factors of chemical technology. Round them may be ranged practically everything that relates to the business of applied chemistry. In its most comprehensive sense, each in turn may be regarded as the parent or genital substance from which flows a countless number of bodies, forming by their mutual actions and reactions the vast array of products which modern manufacturing chemistry has placed at the service of mankind. In the works before us, Dr. Lunge's treatment of these themes is worthy of their importance. The works themselves have already taken an assured position in the literature of chemical technology. In each successive edition their veteran author strives to make them a faithful and adequate reflection of the state of contemporary knowledge and achievement, thereby tending, so long as his ministering care is available, to make that position secure. They have long been recognised as indispensable to the technologist, and each new issue is certain of an immediate welcome.

The volume on coal-tar and ammonia is now in its fourth edition. What enormous changes have come over the industry of tar production, and of the extraction and utilisation of the innumerable substances which enter into its composition, will be evident from even the most superficial examination of the several issues. The rate of progress, indeed, transcends anything to be observed in any other branch of manufacture. Only nine years have elapsed since the third edition made its appearance, but such has been the accumulation of new material in that interval that practically the whole of the chapters—eleven in number—dealing with coal-tar and its products have had to be revised and in great part rewritten. In this section of the work Dr. Lunge has had the assistance of Dr. Kraemer, of Berlin, an acknowledged authority in this branch of chemical technology.

England is still the great tar-producing country of the world, but her supremacy in this respect is threatened by the United States. Tar is mainly obtained from gas-works, from blast furnaces, and from coke-ovens. In the United Kingdom the annual production at the present time approaches a million tons—obtained by the destructive distillation of about seventeen or eighteen million tons of coal—an amount exceeding that of the whole of Europe put together, and probably more than twice the aggregate yield of Germany and France. This country, where benzene was discovered by Faraday, where its industrial extraction was worked out by Mansfield, and where the first aniline colour was made by Perkin, has become simply as the hewer of wood and the drawer of water in this matter. We make the tar, but apparently we can do little with it except sell it to the Germans in order that they shall turn it into that astonishing array of manufactured products which their admirable system of scientific training has taught them how to produce. When in the hour of her humiliation Germany set herself to reconstruct the educational system which has culminated in her present scheme, she forged the most powerful instrument of national development which human forethought could have devised. With it has come her extraordinary commercial development and her ambition to be supreme in the world's markets, and with it, too, she thinks, has come the necessity of being able to protect that commerce, if necessary, by force of arms. What becomes of coal-tar may seem a small matter in determining the course and destiny of nations. But is is absolutely certain that if our university system had been developed, even *pari passu* with that of Germany, and that if those who were responsible for the government of this country, and those who seek to form public opinion, had paid more heed to the signs of the times, we should to-day have less talk about Tariff Reform and of the imperative necessity of more "Dreadnoughts." If Peace has her victories, no less renowned than those of War, we may well ask ourselves if we have always gone the right way to work to secure the victories of peace.

Dr. Lunge's second work—that on sulphuric acid and alkali, now in its third edition—further serves to illustrate the same text. If there was one chemical industry more than another in which Great Britain

was pre-eminent, it was that to which this work relates. Upon it hangs a great number of collateral industries, and their prosperity is bound up together and is mutually dependent. We had abundant stores of most things we needed to extend and develop this industry, and whatever else we required our oversea trade enabled us to procure. That supremacy is challenged. Newer methods have undermined the position which the industry enjoyed with us for so many years, and in which such large amounts of British capital are still locked up. So long as we were concerned with the application of the simplest chemical principles we could hold our own by virtue of our natural advantages. Immediately we were confronted by new processes involving more recondite principles, questions of chemical dynamics, and abstract considerations of mass-actions, reversible reactions and the like, our manufacturers were powerless; nor were they able to find in this country the help they needed. Some of them eventually found it in imported polytechnically trained German and Swiss chemical engineers—for the most part university men with post-graduate technical training—men that the German and Swiss systems produce in abundance.

This system of fighting our industrial battles, in fact, resembles that on which decadent Rome depended for her national existence, and which eventually proved her ruin. It is true, we are beginning to wake up, and sporadic efforts are being made in various directions to rouse the country from its lethargy. Large sums of money are being spent, but whether always wisely is very doubtful. Anything like control, or action directed from outside, is resented, for there is no controlling authority armed with the necessary powers, or, even if it were armed, commands general confidence. We can only hope that "we shall worry through somehow," but if we do, it will only be, as hitherto, by the expenditure of a vast amount of fussy energy, much delay, and waste of money and means.

SOUNDING ROUND THE ANTARCTIC CONTINENT.

Deutsche Südpolar-Expedition, 1901–3. Band ii., Geographie und Geologie. Heft vi., Die Grundproben der Deutschen Südpolar-Expedition, 1901–3. By E. Philippi. Pp. 415–616+xxxi–xxxiii plates. (Berlin: Georg Reimer, 1910.)

THIS memoir forms the sixth division of the second volume—that devoted to geography and geology—of the reports on the German South Polar Expedition, under Prof. von Drygalski, in the *Gauss*. Since the issue of this important memoir, the news has arrived of the great loss which science has sustained by the death of its talented author.

During the whole of the voyage out to the Antarctic Ocean, frequent soundings were taken, directly the equator was crossed. Thirty soundings are recorded between the equator and the Cape of Good Hope, and eighteen more between the Cape and the ice-limit. In the same way, on the return voyage, eighteen soundings were obtained during the somewhat circuitous course by way of the Heard, Kerguelen, St. Paul, and New Amsterdam islands, and by the south of Madagascar back to the Cape; thence to the equator, by a different course to the outward one, thirty-nine further soundings were taken. The methods of obtaining samples of the sea-bottom, in the case of these soundings, and the subsequent treatment of the materials in the laboratory, are fully discussed in the memoir, and the careful descriptions of the specimens of the globigerina and diatomaceous oozes, and of the blue and red muds, are supplemented by mineralogical notes by Dr. R. Reinisch, and chemical analyses by Dr. J. Gebbing. On the chart, a graphic illustration is given of the nature of the sea-bottom at each of the stations, and this part of the work is of considerable value as adding fresh materials for a description of the exact character of the floors of the South Atlantic and Indian Oceans. The descriptions of the soundings and the tabular statements concerning them are very complete, and will prove of great value for purposes of comparison.

The portion of the memoir which will perhaps excite the greatest interest, however, is that which deals with the materials obtained in soundings along the margin of the Antarctic pack-ice. The thirty-three soundings in which specimens of the ocean floor were obtained are valuable as giving indications of the geological structure of that portion of the Antarctic continent lying between the meridians of 80° and 96° E. The mineral fragments, which have been very carefully examined and described, must have been brought down by glaciers from the interior of the continent. Among the larger fragments occur granitic rocks, gneisses, amphibolites, and other crystalline schists, with a red quartzitic sandstone, coarse or fine grained, and, more rarely, gabbro. Of recent volcanic rocks, fragments of basalt and of volcanic glass are recorded from a few stations only, and it is suggested that possibly these may have come, not from the continental lands, but from some island or islands lying within the limits of the ice-pack, or possibly they may be the products of submarine eruptions.

The long list of minerals given from the different soundings confirms the conclusions drawn from the study of the rock-fragments, for they nearly all belong to species characteristic of granitic rocks and the older crystalline schists. The study of the sandy or muddy materials in which these rock and mineral fragments are embedded shows that, as a rule, they are free from calcareous matter. Of the thirty-three deposits examined, only one was found to contain any considerable proportion of calcium carbonate, nearly 20 per cent.; four others contained from 1 to 5 per cent., and four others mere traces; the remaining twenty-four were perfectly free from all calcareous matter. Although the glacial muds graduate, in passing northwards towards warmer seas, into the diatomaceous ooze, the remains of the microscopic algæ are not abundant in the muds from the borders of the pack-ice. Some foraminifera occur, and glauconite was detected in five of the soundings.

The study of this very complete and suggestive memoir cannot fail to increase the regret which must be universally felt in the scientific world at the death, so early in his career, of its distinguished author.

J. W. J.

READABLE BOOKS IN NATURAL KNOWLEDGE.

Wonders of Physical Science. By E. E. Fournier. Pp. viii+201.

Tillers of the Ground. By Dr. Marion I. Newbigin. Pp. viii+224.

Threads in the Web of Life. By Margaret R. Thomson and Prof. J. Arthur Thomson. Pp. vii+198. (London: Macmillan and Co., Ltd., 1910.) Price 1*s.* 6*d.* each.

SOME years ago a new series of "Readable Books in Natural Knowledge" would have been a gift of doubtful value to the teacher. Written by the capable hands that have made the present volumes, they could not have failed to awaken here and there the genuine passion for scientific inquiry, and so would have seemed to justify their existence. But, speaking generally, the more completely such books had succeeded in "popularising" the labours of the *savant* the further they would have been held to direct the attention of the teacher from the proper aim of instruction in science. We now recognise that that aim is not so much to make the pupil acquainted with certain ranges of facts as to train him in the exercise of one of the most important forms of human activity. Thanks largely to the tireless propaganda of Prof. Armstrong, this aim is at present pursued with more or less intelligence wherever it is claimed that science is being taught. The boy learns that the essence of science consists in putting a clear question to nature and wresting from her a clear answer to it. In favourable circumstances he acquires some of the mental habits essential to success in this pursuit, or at any rate is made to see that such success comes only of faithfulness and labour.

It was natural that the training value of heuristic methods should be emphasised by their advocates since this element was almost entirely absent from the older didactic methods. But modern pedagogy, instructed by the results of psychological inquiry, has become critical of the claims of a subject to train or cultivate "faculties," and prefers to find in the nature of the subject itself the justification for teaching it. Thus the prime reason for teaching science is that, intrinsically and in its results, the scientific activity is one of the greatest and worthiest types of human effort. An education that does not give a sympathetic acquaintance with it is, therefore, necessarily incomplete. Whatever other arguments may be urged in their favour, heuristic methods in science teaching are rendered necessary by the fact that by them alone the pupil is made actually to exercise the scientific activity, and so to gain direct knowledge of one of the cardinal forms of human achievement. But when by first-hand experience he has genuine knowledge of the scientific activity, he should also have opportunities of appreciating its significance in human history. It is precisely to serve this function that the present series of "Readable Books" has been designed. To quote the publishers' note, they "aim at exalting the scientific spirit which leads men to devote their lives to the advancement of natural knowledge, and at showing how the human race eventually reaps the benefit of such research."

It may be said at once that in the first three books of the series this aim has been already admirably fulfilled. The authors have approached their task in the right temper, and have, on the whole, been remarkably happy, both in the choice and in the treatment of their topics. Mr. Fournier takes ground, a great part of which has been worked over by predecessors, but he has evidently gone himself to the works of the great physicists, and his chapters have the freshness and force derived from this direct contact. Dr. Marion Newbigin tells of the evolution and spread of food-plants with an epical directness and unity of plan. An episode in the development of Transatlantic commercialism—such as the transportation of Smyrna figs to California—becomes in her hands a wonderfully impressive illustration of the working of the scientific spirit. Mrs. and Prof. J. A. Thomson have taken a subject which hardly lends itself to the same unity of treatment. In part, their object is to exhibit the dependence of man upon deliberate or unconscious partnership with animals—such as the domesticated animals on the one hand, and earthworms on the other. They come nearer to the special aim of the series in the chapters where they show what tremendous results depend upon the scientific investigation of the life-histories of microscopic parasites. It is unnecessary to say that both parts of their programme are admirably executed.

A notable characteristic of each of the books is that they bring the tale of scientific conquests down to our own days. Thus Mr. Fournier describes Röntgen's discovery of the X-rays, and tells the story of aviation down to Blériot's flight across the Channel last year. Dr. Newbigin gives capital chapters on the work of Mendel, de Vries, and their followers. Prof. and Mrs. Thomson have a chapter on the relation between mosquitoes and malaria, as well as one on Pasteur. In short, these most interesting and stimulating little books initiate a series which will at once prove of great value as an adjunct to the systematic instruction of the class-room and laboratory, and, if continued in the same spirit and with the same ability, will become an almost indispensable part of a school equipment for science teaching.

T. P. N.

SALMON AND TROUT.

Life-history and Habits of the Salmon, Sea-trout, Trout, and other Fresh-water Fish. By P. D. Malloch. Pp. xvi+263. (London: Adam and Charles Black, 1910.) Price 10*s.* 6*d.* net.

THIS book is almost entirely devoted to the salmon of the Tay, sea-trout, and brown trout. "The other fresh-water fish" are but slightly dealt with, and the chapters allocated to them call for no particular notice, save to direct attention to the start-

lingly inaccurate assertion that "Prof. Grassi, of Rome, discovered the breeding grounds (of the eel) to be out in the Atlantic Ocean from Norway, Denmark, France, and Spain in some parts 1000 miles from shore."

With salmon and trout the case is different; any work upon this subject by a fisherman and fishery manager of Mr. Malloch's experience cannot fail to be of interest. Some readers will doubtless not be prepared to accept in their entirety all the views advanced, but all will be grateful to the author for recording the conclusions which he has drawn from a very wide personal experience.

The most interesting feature of the book is the really excellent series of illustrations, reproduced from photographs of Tay salmon of all ages and conditions, and of sea-trout and brown trout from various rivers and lochs. Illustrations such as these give a far better impression of the changes due to growth and condition and the variations caused by environment than any letterpress. The investigations of the Scottish Fishery Board and the Department of Agriculture in Ireland have familiarised us with the great individual difference in the period spent by salmon in the sea, and Mr. Malloch figures salmon which were marked as smolts and subsequently re-captured on their return to the river after a longer or shorter sojourn in the sea, and discusses the probable length of such sojourn. He expresses himself as "fully convinced that many (Tay) fish from 40 lb. and upwards are on their first return from the sea when they are captured in fresh water"; we could wish that some definite evidence were forthcoming in support of this conviction, for a 40-lb. salmon is presumably eight, or at least seven, years old, and Calderwood has stated that "it appears to be somewhat unusual for a fish to remain till its fourth sea year" (*i.e.* its sixth year) "without spawning."

In the Tay, salmon run at all seasons of the year, and Mr. Malloch is of opinion that the clean winter fish which run in October remain thirteen months in fresh water before spawning. We must confess to feeling sceptical on this point, more particularly as there seems to be nothing to show that such fish may not drop back again to the sea after a short sojourn in fresh water without spawning. In the case of the Blackwater (mentioned in this context as a spring river) there is some positive evidence that clean early-spring fish do drop back into the sea.

The opinion now generally held that the "bull-trout" of the Tay is a salmon is confirmed by an illustration of such a fish side by side with a salmon of the same size and weight; we understand Mr. Malloch to regard "bull-trout" as salmon which have spawned and again ascended the river as mended fish, a view which seems hardly consonant with that held by Calderwood, though not inconsistent with the results of some of the marking experiments conducted by the Scottish Fishery Board. It cannot, of course, be seriously suggested that all salmon, after once spawning, become "bull-trout."

Some space is, very properly, given to a consideration of the deductions to be drawn from an examination of the scales of salmon. While the figures given by Mr. Malloch are excellent, we find his explanations in the text rather difficult to follow; the generalisation that a salmon adds sixteen rings to its scale in ea year of its life, so long as it feeds and grows, is not borne out by the scales figured or by the observations of other persons; the two years spent as a parr and smolt would, in fact, seem to account for a number of rings, varying from about twenty to twenty-seven, while from twenty to thirty rings may be added in any subsequent year spent wholly in the sea.

Such matters as the spawning and feeding of salmon in fresh water and their movements in tidal rivers are briefly discussed, and interesting figures are given of land-locked salmon up to three-quarters of a pound in weight.

Did space permit we would willingly quote freely from the chapters dealing with sea-trout and brown trout, and in particular from a most interesting discussion of the effect of environment on the latter fish, and the lessons to be drawn therefrom in the stocking and management of fisheries.

In conclusion we must deplore the entire absence of either index or detailed table of contents.

L. W. B.

NON-EUCLIDEAN GEOMETRY.

Theories of Parallelism: an Historical Critique. By W. B. Frankland. Pp. xviii+70. (Cambridge: University Press, 1910.) Price 3*s.* net.

THE appearance of this tract is a welcome sign of the growing interest in the foundations of geometry. Those who, greatly daring, first disputed or denied Euclid's fifth postulate were treated, if not as charlatans, at least as idle speculators, whose theories, even if sound in the abstract, had no relation to actual space. It may be added that the earlier works on the non-Euclidean geometries were not very attractive to the average mathematician, because they were either so analytical that the reader was inclined to regard their geometrical interpretation as a mere *façon de parler*, or so vague and intuitive as to raise a suspicion of want of rigour.

Things have altered so much, not in substance, but in mode of presentation, that it may fairly be said that anyone with a knowledge of spherical trigonometry and elementary calculus may satisfy himself of the validity and coordinate rank of the elliptic, hyperbolic, and parabolic (or Euclidean) geometries; and he could hardly wish for a better introduction to the subject than that which Mr. Frankland has provided.

The tract falls naturally into three parts. The first, with remarkable brevity and clearness, gives the principal formulæ derived from the assumptions that the area of a polygon of n sides is proportional to the difference between the sum of its interior angles and $(n-2)\pi$, and that Euclidean geometry holds for infinitesimal figures. The second part gives, in separate paragraphs, short accounts of forty contributors to the theory, ranging from Euclid to Dodgson. This list seems fairly complete, with one noteworthy exception—Sophus Lie. In the third volume of his "Theorie der Transformationsgruppen" (section v.) Lie gives a

masterly and exhaustive critique of the subject from an analytical point of view, and his discussion of Helmholtz's axioms is particularly instructive.

The third part of the tract consists of two notes—one developing the metrical formulæ of elliptic geometry, and the other dealing with planetary motion in elliptic space, with a law of attraction expressed by the formula $P=\frac{\mu}{k^2}\operatorname{cosec}^2\frac{r}{k}$, where k is the absolute constant of the space considered. The results are, in some respects, curiously analogous to the Newtonian ones; but there are also striking differences—for instance, the uniform description of areas about the centre of force does not hold good.

Mr. Frankland's critique deserves a wide circulation, and will doubtless do much to make the general public more familiar with what is, after all, a matter of great philosophical interest, that can be explained, apart from demonstration, to any intelligent person. There is no reason at all why a schoolboy, who has made some progress in geometry, should not be made acquainted with the main characteristics of the three possible systems, and realise, to some extent, the transformation so recently undergone by the oldest of the sciences. G. B. M.

FOREST FLORA OF THE BOMBAY PRESIDENCY.

Forest Flora of the Bombay Presidency and Sind. Vol. i., Ranunculaceæ to Rosaceæ. By W. A. Talbot. Pp. vi+508+xxvi. (Poona: Printed by Government at the Photozincographic Department, 1909.)

IN 1894 Mr. W. A. Talbot issued a useful "List of the Trees, Shrubs, and Woody Climbers of the Bombay Presidency." A new and improved edition of this "List" appeared in 1902. In the present work Mr. Talbot has supplied what is essentially a more complete and considerably enlarged edition of the "List," with full accounts of all the species included, and illustrations of the more important ones. Those using the "List" will find full accounts of the species it includes in Dr. T. Cooke's "Flora of the Bombay Presidency"; the main purpose of this "Forest Flora" we may, therefore, assume to be the provision of an illustrated work of reference for Bombay comparable with the "Flora Sylvatica" which Col. Beddome prepared for Madras forty years ago. If this assumption be correct, the provision of yet another series of plant descriptions, marked as they are by all the care and accuracy which characterise Mr. Talbot's work, cannot be said to be supererogatory.

The quarto size seems to have been adopted in order to render the "Flora" uniform with the corresponding work for southern India rather than because of the nature of the illustrations, only two of which occupy the whole of a page. It seems, therefore, doubtful whether Mr. Talbot is right in thinking that the size of the work has been kept as small as possible, or justified in hoping that it may not prove too unwieldy for transport in the baggage of a forest or district officer.

The text is clearly and carefully printed, but the glazed paper used is heavy, unpleasant to handle and to look at, and does not promise to be durable in damp localities. No doubt this type of paper has been chosen on account of the process employed in the reproduction of the illustrations, which, unfortunately, as matters stand, are the least pleasing portion of the work. The drawings made use of have not lent themselves at all well to reproduction by the process adopted, a statement of fact which involves no reflection either upon the process or upon the drawings. These, indeed, one can readily imagine to have been pleasing in their original form, though they have the disadvantage of falling short of what is desirable in a work of this kind, since for the most part they do no more than display the habit of the species illustrated, and rarely include analyses of the flower.

APPLIED CHEMISTRY.

Chimica Generale e Applicata all'Industria. Vol. ii.: Chimica Organica. By Prof. Ettore Molinari. Parte i.: pp. xvi+416; parte ii.: pp. xii+417 to 979. (Milan: Ulrico Hoepli, 1908–9.) Price 21 lire the 2 vols.

THE volumes with the above title form a supplement to the treatise on inorganic chemistry by the same author, already reviewed in NATURE (vol. lxxi., p. 339). The same general plan has been followed in these later volumes as was adopted in the case of inorganic substances, the treatise differing from nearly all other smaller treatises on organic chemistry in giving very full details of industrial operations. The book is not, however, a treatise on technology in the narrower sense of the word, the theoretical side being by no means neglected. A very great deal of thoroughly up-to-date information of processes and plant is imparted, but at the same time there is due regard to the theory of the operations. The work is excellently illustrated with cuts of the latest kinds of machinery. An idea of the character of the work may be conveyed by stating that sixty-five pages of small print are devoted to the manufacture of sugar, and that the processes involved are described clearly but concisely, the illustrations being very well chosen. Such a work must necessarily prove of good service to students who intend to devote themselves to industrial chemistry and are desirous of becoming acquainted with general manufacturing operations. There are many signs that the author has spared no pains to make himself acquainted with the latest facts and processes, references in some cases being given to results brought before the recent International Congress of Applied Chemistry in 1909.

It is nowadays obviously impossible for any one individual to give an authoritative account of all the different branches into which industrial chemistry is subdivided, and in such a work as that under review it would, no doubt, be easy for specialists to detect several errors. Thus, for example, the 1898 Goldenberg process of analysis of tartaric acid material described on p. 451 was superseded by the 1907 process,

and this was again modified in 1909. Certain statistical information given is, too, of doubtful correctness. Names are frequently misspelt. But putting aside minor blemishes of this kind the work is of a decidedly useful nature, and, like the inorganic portion, to be commended. It may be noted that a German translation of the whole work is in progress, so that it may shortly become more accessible to the English student. W. A. D.

OUR BOOK SHELF.

Guide to the Crustacea, Arachnida, Onychophora, and Myriopoda exhibited in the Department of Zoology, British Museum (Natural History). Pp. 133; 90 illustrations. (London: Printed by order of the Trustees of the British Museum, 1910.) Price 1*s*.

THIS "Guide" admirably fulfils its functions; it is written in a clear style, and indicates tersely the main points of interest associated with the chief families and genera. The principal characters of each subdivision—class, order, tribe, family—are concisely stated, and those of its members are selected for mention which most aptly illustrate points in morphology or distribution, or show some striking habit. The section on the Crustacea opens with a short account of the lobster, its external features and appendages, internal organs, development, moulting, and the asymmetry of its chelæ. Short notes are added on the modifications caused by parasites and on adaptations to environment.

The systematic account of the Crustacea, in addition to stating the characters of each subdivision, contains a large number of interesting references to morphological and distributional points which make it valuable apart from the special purpose for which it was prepared. To give two instances—(1) the formation of a respiratory siphon which takes place in the Albuneidæ by apposition of the antennules, but in Corystes by association of the antennæ; and (2) the appearance of Apus in Scotland in 1907, which is ascribed to the introduction of the eggs, perhaps on the feet of birds, from the Continent. The Arachnida, including Limulus and the Eurypterines, and the Myriopoda are dealt with in a similarly interesting manner, and short notes are added on the Trilobita, Pycnogonida, Pentastomida, and Oncychophora. A little more space might well have been devoted to the Ixodidæ, in view of their great importance in connection with the spread of disease in man and animals. The illustrations, many of which are new and are prepared from photographs of the specimens exhibited, are excellent, and well support the text.

Popular Astronomy. By the late Prof. Simon Newcomb. Pp. xx+580+5 star maps. (London: Macmillan and Co., Ltd., 1910.) Price 8*s*. 6*d*. net.

ASTRONOMY has no doubt made progress in several directions since the late Prof. Newcomb revised his renowned work; nevertheless, if the lamented author were alive to re-write his book at the present time, by far the greater part could not be improved upon. The extensions of knowledge take place at the frontiers of a science, while the main body of fact and principle remains unaltered. While, therefore, this cheap edition of Prof. Newcomb's "Popular Astronomy" is issued without additions referring to recent developments, the volume can fairly be described as one of the most lucid and authoritative statements of the foundations of astronomical science available even now. To let such a work pass out of print would have been a misfortune, and we trust that the issue of an edition at less than half the original price will be the means of making many new readers familiar with its merits.

Naturwissenchaftliches Unterrichtswerk für höhere Mädchenschulen. Teil iv., Lehrstoff der iv. Klasse. By Dr. K. Smalian and K. Bermau. Pp. 152. (Leipzig: G. Freytag, 1910.) Price 2.50 marks.

THIS volume, one of a series graded for successive school classes, has been prepared to comply with official regulations, wherein presumably lies the reason for combining a triad admixture of botany, zoology, and mineralogy. The aim of the authors has been directed less towards a training manual and more towards providing a compendium of information on objects which are met with in daily life. The book contains an accurate but condensed collation of facts concerning cryptogamic and economic botany, the zoological groups of mollusca, vermes, and cœlenterata, and common or useful minerals. It is plentifully illustrated with good text-figures and a dozen coloured plates.

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.*]

Pwdre Ser.

IN my former communication on this subject I gave all the information I had been able to collect respecting the popular belief as to the masses of white jelly found in my experience on mountain pastures, but, according to the observations of others, on different kinds of ground and at various seasons.

I recently procured a specimen of the jelly, and quoted a letter from Mr. Arber, to whom I had sent it, giving the opinion of Mr. Brookes, to whom Mr. Arber had referred it. After that was written I received the following note from Mr. Brookes, under the date April 4:—"The 'jelly' had been gathered several days before it reached me, and hence its condition was not suitable for examination, several putrefactive organisms having begun to flourish upon the jelly in the meantime. The remains of the substance which I saw seemed to be most like the zooglœa stage of some bacterial organism or the plasmodium of a myxomycete. The 'jelly' itself had no cellular structure. There was no nostoc present or any allied organism."

More recently I received a specimen which Mr. Burnett, headmaster of the Grammar School at Kirkby Lonsdale, found in the Rawthay Valley, some miles above Sedbergh. This also I sent to Mr. Brookes, who writes (July 26) that "the jelly-like mass sent from Kirkby Lonsdale is undoubtedly the plasmodium of a myxocete," and adds that he is "keeping it to see whether it will give rise to spores."

Mr. Worthington Smith, in a letter dated June 24, says:—"Perhaps you will find the substance so accurately described by you in this week's NATURE under the generic name of Zooglœa; the name as a genus may be obsolete now, but I think that in past times it was placed amongst the algæ, perhaps near Nostoc, and afterwards included in the Schizomycetes. However this may be, I know the substance very well, and I have often had it sent on to me in the past (when I used to answer correspondents for some of the horticultural papers) as a fungus—a Tremella—difficult to trace. I have heard it, as well as Nostoc, associated with fallen stars amongst rustics."

These authorities, as well as Miss Fry (NATURE, June 30),

agree as to the nature of the Pwdre Ser, and I must say that whenever I have observed its manner of occurrence it has seemed to me to grow out of the sod—but I would not like to say that what I have seen has always been the same kind of matter.

The very circumstantial account given by Morton, that something of the kind is disgorged by birds, is confirmed by other later observers.

Although we must not too hastily accept what is undoubtedly a *vera causa* as the only explanation, we may feel that we are moving in the right direction to find the answer to the question, What is it?

The question why it is associated with falling stars has received a plausible explanation from Messrs. Grove and Griffiths (NATURE, July 21); but falling stars do not appear to hit the ground so that an observer can walk up to the spot where they seem to have fallen, as in the case of lightning or thunderbolts, and if we bring in possibilities of other luminous bodies we raise the difficult question of lambent fires, &c. The star-like radiating form of the jelly-fish, like that of the star-fish, is sufficient to explain the name given by Admiral Smyth (July 21, p. 73).

While our botanical friends are finding out for us what it is, may I hope that some of our literary friends will trace the belief back further than the sixteenth century, when we find it accepted as if founded upon well-known facts? T. MCKENNY HUGHES.

July 29.

The Blood-sucking Conorhinus.

IT may interest readers of NATURE to be informed that the great South American bug figured on p. 142 of the issue of August 4 punished Charles Darwin when travelling in the Pampas, happily without infecting him with its trypanosome (see "Journal of a Naturalist," ed. 1845, p. 330). J. D. H.

The Camp, near Sunningdale, August 5.

[SUBJOINED is the description to which our correspondent refers.—ED. NATURE.]

"WE slept in the village of Luxan, which is a small place surrounded by gardens, and forms the most southern cultivated district in the Province of Mendoza; it is five leagues south of the capital. At night I experienced an attack (for it deserves no less a name) of the *Benchuca*, a species of Reduvius, the great black bug of the Pampas. It is most disgusting to feel soft, wingless insects about an inch long crawling over one's body. Before sucking they are quite thin, but afterwards they become round and bloated with blood, and in this state are easily crushed. One which I caught at Iquique (for they are found in Chile and Peru) was very empty. When placed on a table, and though surrounded by people, if a finger was presented the bold insect would immediately protrude its sucker, make a charge, and, if allowed, draw blood. No pain was caused by the wound. It was curious to watch its body during the act of sucking, as in less than ten minutes it changed from being as flat as a wafer to a globular form. This one feast, for which the benchuca was indebted to one of the officers, kept it fat during four whole months; but, after the first fortnight, it was quite ready to have another suck."

The Early History of Non-Euclidean Geometry.

IN a recent number of NATURE (June 30) there appeared a review of a book by G. Mannoury on the philosophy of mathematics, and the reviewer emphasised a statement of the author to the effect that the claim for Gauss that he was the first to assert the possibility of a non-Euclidean geometry is threatened by F. K. Schweikart, who in December, 1818, sent a note to Gauss asserting the existence of a geometry in which the sum of the angles of a triangle is less than two right angles. The facts about Schweikart were made known fifteen years ago by Stäckel and Engel ("Theorie der Parallellinien," p. 243), and the actual documents were published in Gauss's "Werke," Bd. viii. (1900). It must be admitted that Schweikart arrived independently at this result, though it is not so obvious that he had forestalled the "giant mathematician." Schweikart states his hypothesis very clearly, and explains that Euclidean geometry is a special case of a more general geometry. On the other hand, Gauss was interested in the theory of parallels from at least 1799; and some time between 1808 and 1816 he arrived at the belief that non-Euclidean geometry was possibly true, for in 1808 he asserted that the idea of an *a priori* linear constant (the "space-constant") was absurd, while in 1816 he declared that, while seemingly paradoxical, this idea was in no way self-contradictory, and that Euclid's geometry might not be the true one. In his comments on Schweikart's note, he exhibits quite an extensive knowledge of non-Euclidean trigonometry.

Of course, the development of non-Euclidean geometry and trigonometry is due independently to Lobachevskij (1829), and Bolyai (1832), and even that was worked out to a large extent previously by Lambert (1786), and still earlier by the Italian Jesuit Saccheri (1733), though neither of these two conceived for a moment the possibility of non-Euclidean geometry being true.

It is interesting in this connection to recall the hesitancy of Cayley to accept non-Euclidean geometry, although he himself practically inaugurated a new epoch. He never seemed quite to appreciate the subject, and on one occasion, at least, fell into a mistake in writing about it. In his article "On the Non-Euclidean Plane Geometry," Math. Papers, vol. xiii., p. 237, he inadvertently takes the equatorial circle of the pseudosphere (the surface of revolution of the tractrix) as representing the points at infinity, whereas the absolute is only represented by a single point, viz. the point at infinity on the pseudosphere.

D. M. Y. SOMMERVILLE.

The University, St. Andrews, July 26.

The Total Solar Eclipse of April 28, 1911.

WHILST astronomers who intend to observe this eclipse are choosing from amongst the Vavau, Tau, Nassau, and Danger Islands, the best one on which to land, it may be useful to state the totalities of the eclipse in these islands.

From the calculation of the phases obtained by the Besselian method, and with the data of the "American Ephemeris," I have found the following values:—

		m.	s.
Vavau (arch. of Tonga)	Totality =	3	36·6
Tau (arch. of Samoa)	,, =	2	13·0
Danger (arch. of Union)	,, =	3	19·4
Nassau (,,)	,, =	4	9·9

The geographical coordinates of these islands, adopted in the calculations, are respectively:—

Islands	λ	φ
Vavau	− 173° 59·0′ ...	− 18° 39·0′
Tau	− 169° 32·0′ ...	− 14° 13·5′
Danger	− 165° 45·0′ ...	− 10° 53·0′
Nassau	− 165° 25·0′ ...	− 11° 33·0′

Rome, July 29. PIO EMANUELLI.

Mars in 1909 as seen at the Lowell Observatory.

THE accompanying prints are photographs of the globe of Mars, representing the details seen on the planet at the Lowell Observatory at the last opposition in 1909.

These maps demonstrate strikingly the development of the canals from the melting cap, shown by the number of canals visible in the southern hemisphere at the time, especially about the south pole, and by the absence of canals in the northern one, notably in the neighbourhood of the north polar cap.

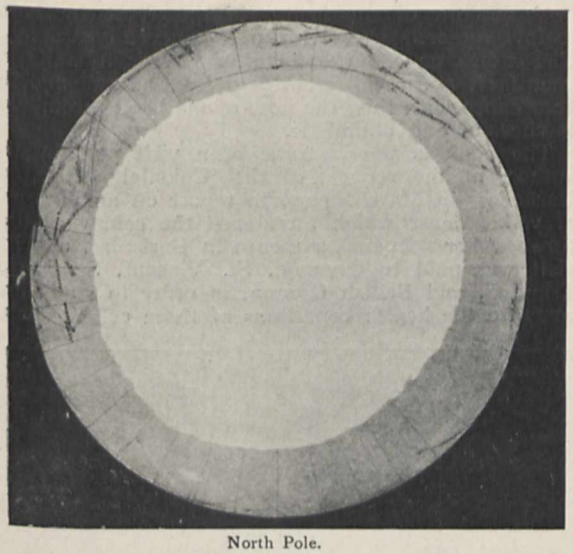
The canals numbered 659 or 660 are the two great new canals, of which the account has already been published, and of which the size enabled the advent to be established with certainty. Several other examples of fresh origination are to be seen on the charts, about which the evidence is hardly less conclusive.

The white patches at some distance from the south pole

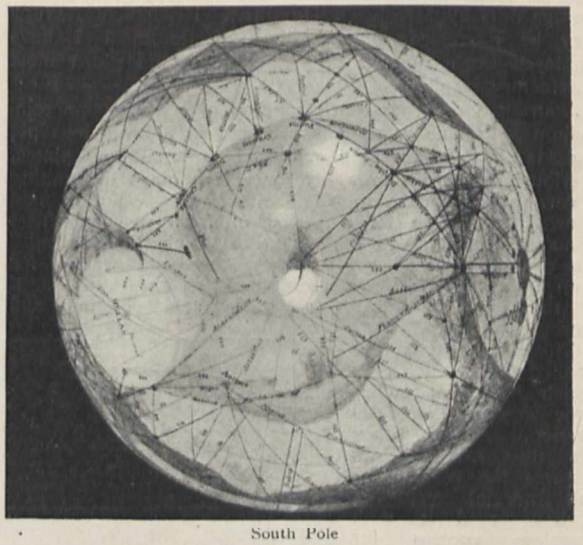
mark the first frost of the autumn in the planet's southern hemisphere. These patches were photographed, as were also many of the canals.

The number of the latter photographed at Flagstaff since 1905 is between fifty and one hundred.

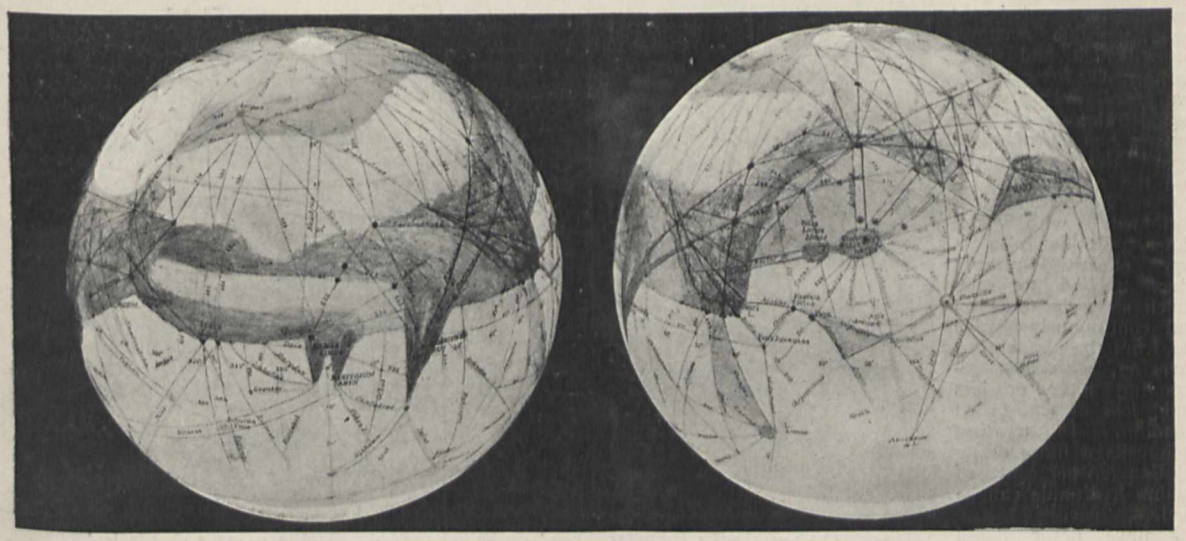
Boston, U.S.A., July 22. PERCIVAL LOWELL.



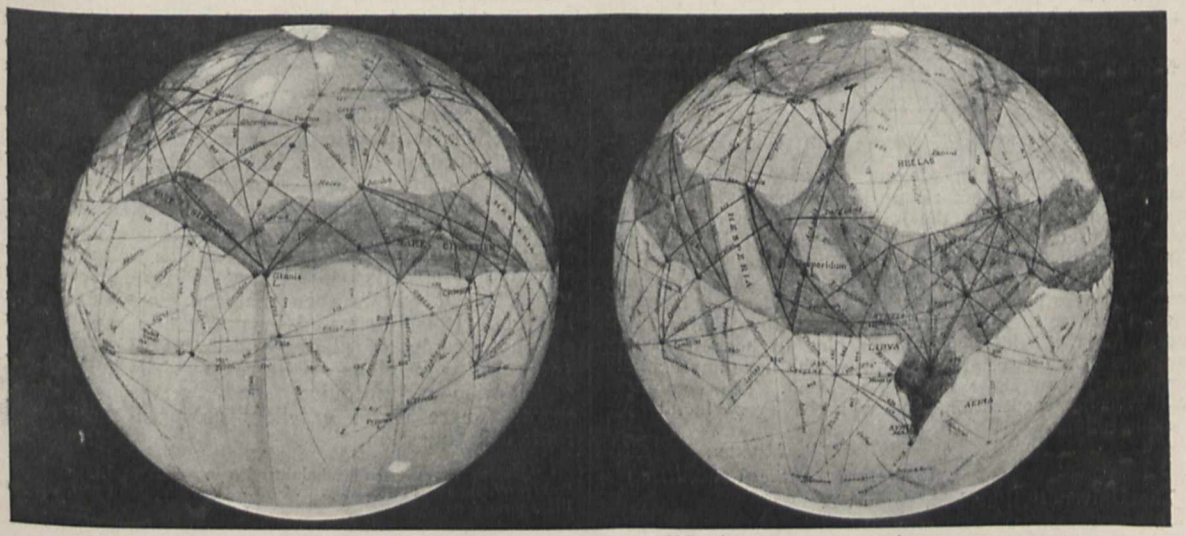
North Pole.



South Pole



λ=90°.



λ=180°. Lowell Observatory Photographs of Mars in 1909. λ=270°.

Treatment of Storage Cells.

IN the "Notes" of NATURE for July 28 (p. 118) reference is made to an article on the renewal of sulphated storage cells by Mr. J. O. Hamilton. Readers of NATURE may be interested in a method of treatment I have employed for a number of years, which has given most satisfactory results.

A strong (30–40 per cent.) solution of crude, commercial sodium hydroxide solution is prepared in a large iron pot and is heated to boiling. The accumulator plates, previously washed thoroughly for several days in running water, are dipped into the boiling soda solution and allowed to remain for a period of from five to fifteen minutes, depending on the extent to which "sulphating" has taken place. They are then removed and washed for several days in fresh water, after which they are placed in the jars with fresh sulphuric acid solution and thoroughly charged.

This treatment can be applied to any cells which have not undergone structural disintegration, and when properly carried out restores the cell to its full normal capacity. I have used it with complete success for treating a set of six large portable accumulators which had stood uncharged for nearly five years, during which period almost all the water had evaporated from the electrolyte, and the greater part of the sulphuric acid had combined with the plates. It is also a very effective remedy when applied to cells which show local action and continuously evolve gas from the plates after charging, with a corresponding more or less rapid loss of charge on standing. In treating such cells a more dilute solution (20 per cent.) of sodium hydroxide can be used.

I have never found a cell too completely "sulphated" to be restored by this treatment.

BERTRAM B. BOLTWOOD.

Munich, Germany, August 7.

The Sheffield Meeting of the British Association.

MAY I ask the favour of your columns to bring to the notice of intending visitors to the meeting of the British Association in Sheffield the fact that, at the reception to be given to the association by the Duke of Norfolk, the Chancellor of Sheffield University, on Tuesday evening, September 6, exhibits are being arranged of new experiments, apparatus, specimens, &c., of scientific interest? The committee of the University formed to make arrangements for the exhibition will be glad to hear from any members of the association or others who have any exhibits which they can show on this occasion. The committee will welcome cooperation, and will give every facility for demonstrations.

S. R. MILNER.

(*Secretary to the Committee.*)

The University, Sheffield, August 8.

YELLOW JACK AND THE WEST INDIES.[1]

THIS is a popularly written book, giving an account of the health of the West Indies of to-day, as compared with one hundred years ago. The motto on the title-page is "Wear a smile on your face, and a flower in your buttonhole," and, in accordance with this, the note of the book throughout is cheerful and optimistic.

The book is the outcome of a visit paid by the author, at the request of the Colonial Office, to Barbados in March, 1909, to report on an outbreak of yellow fever which threatened the colony at that time. After spending a month in Barbados, a flying visit was paid to Grenada, St. Vincent, St. Lucia, Trinidad, and British Guiana, in order to study and compare the health conditions of these colonies with those of Barbados. Further, in a series of appendices, the health progress of Martinique, Guadeloupe, Cuba, Porto Rico, Jamaica, the Bahamas, and British Honduras is summarised.

FIG. 1.—Belleville, Barbados. From "Health Progress and Administration in the West Indies.'

The diseases mostly dealt with are yellow fever, malaria, filaria, plague, and ankylostoma. The medical organisation of the different islands to improve sanitary conditions, to destroy mosquitoes, to prevent the introduction of disease, and to stamp out existing diseases, is discussed at length. A large part of the book is given up to the various health ordinances and sanitary by-laws issued by the various Governments. From this it will be seen that the scope of the book is wide. It is illustrated by many fine reproductions of photographs of places and scenery in the West Indies; also by plans of the towns visited, giving the distribution of mosquitoes and the diseases due to them. There is an excellent coloured map of the region in question.

[1] "Health Progress and Administration in the West Indies." By Sir Rubert W. Boyce, F.R.S. Pp. xv+328. (London: John Murray, 1910.) Price 10*s*. 6*d*. net.

The first chapters are devoted to an historical account of the health conditions of the West Indies at the beginning of the nineteenth century. These are rather hastily and loosely written, but suffice to show that at that time these islands were veritable death-traps. It was the newcomer who was attacked, and no one felt safe until he had at least passed through an attack of yellow fever, and so become, as the saying was, acclimatised. Now, by the introduction of drainage, pipe-borne water supply, the destruction of mosquito breeding-places, and general sanitation, these diseases have almost disappeared, and the islands are becoming the sanatoria nature surely intended them to be.

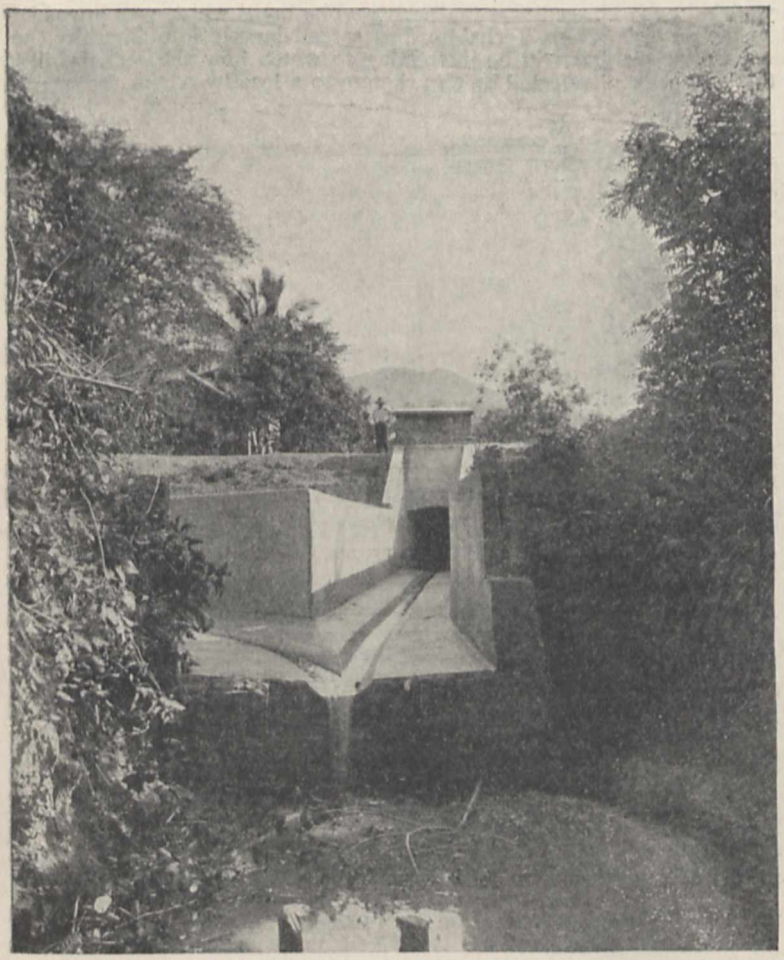


FIG. 2.—Large Concrete Drain, Port of Spain, Trinidad. From "Health Progress and Administration in the West Indies."

Truly, according to Sir Rubert, the victories of modern medicine over tropical diseases in the West Indies during the last few years have been marvellous. Owing to the discovery of the cause, and the fact of it being water-borne, cholera is now unknown. Malaria has given up its secrets, and it is now merely a matter of putting the knowledge gained into practice to stamp out that scourge of the Antilles. Yellow fever, which a hundred years ago blotted out whole regiments, is now relegated to the place of a pathological curiosity. Ankylostoma disease, one of the most potent destroyers of health and energy in the tropics, is now understood, and can be coped with. Prof. Boyce's book is full of instances of man's enlarging dominion over that unlovely domain of nature—disease.

There are some signs, as mentioned above, of haste in the production of the book, especially in the second chapter. For example, a table is given on p. 8 which is meant to show that the newly-arrived seaman was frequently attacked, but no figures are given of the total number of seamen dealt with. Again, on p. 16, the following sentence occurs:—"From 1817 to 1836, in the garrisons in Jamaica, amounting at that time to 2578 men, the deaths from intermittent and remittent fevers rose to 258 men." This probably means a yearly rate, but it is not so stated. Other awkward sentences are:—"Swooped down on every ship, war vessel, and merchantman." "These were the days which tried the nerve and endurance of our fathers and grandparents, or at least those of them who survived the deadly disease of not so long ago." "In fact, the entomological equipment of Trinidad is exceedingly good and is bearing excellent fruit." "So as to reap at once the advantages which must accrue." "In ten out of the fifteen yards larvæ were found in the barrels, and the barrels nearly always contained larvæ."

To conclude, this book, by bringing together and presenting in an easy form the efforts now being made by the various Governments in the West Indies towards the improvement of the health of their respective islands, and the brilliant results which have already rewarded their labours, will be of great use to all officials whose duty it is to look after the health and well-being of tropical populations.

THE VERTEBRATE FAUNA OF CHESHIRE.[1]

THERE are few counties in England which present a variety of natural features so favourable to a varied fauna as does Cheshire. It possesses undulating plains; heather-clad or wooded hills of considerable altitude; numerous rivers, meres, lakes, and "flashes"; tree-clad vales; forest, woods, plantations, and shrubberies; marshes and remnants of mosses, besides considerable estuarine frontages and half the broad "Sands o' Dee." The county is freer from manufactories, with their destructive smoke and fumes, and has less of its area under the plough than most of its neighbours. It is chiefly given up to sheep and dairy farming, necessitating extensive grasslands, and to large market gardens and nurseries, which are, on the whole, friendly to the increase of certain classes of animal life. Still, with all these advantages, the vertebrate fauna of Cheshire is not so rich as one might expect, nor so rich, indeed, as it once was.

[1] "The Vertebrate Fauna of Cheshire and Liverpool Bay." Edited by T. A. Coward. In two volumes. Vol. i., The Mammals and Birds of Cheshire. By T. A. Coward and C. Oldham. Pp. xxxii+472; with illustrations from photographs by Thomas Baddeley. Vol. ii., The Dee as a Wildfowl Resort. By John A. Dockray. The Reptiles and Amphibians of Cheshire. By T. A. Coward and C. Oldham. The Fishes of Cheshire and Liverpool Bay. By James Johnstone. Pp. xl+210; with illustrations from photographs by Thomas Baddeley. (London: Witherby and Co., 1910.) Price 26s. net the 2 vols.

"During the last half-century farming has greatly improved . . . old hedgerows have been grubbed up and replaced, and waste lands and mosses have been reclaimed and cultivated; changes no doubt advantageous to the common weal, but deplorable when viewed from the standpoint of the naturalist."

That is, the increase of population and the movement and disturbance of nature due thereto, and the incessant hustling by civilisation, are in Cheshire, as everywhere else, tending to "move on" every form of life.

Although the cover bears the title of "Fauna of Cheshire," these volumes deal only with the vertebrates of the county. The editor, Mr. Coward, and his co-contributor-in-chief, Mr. Oldham, are responsible for the greater part of the fauna. Both are well known for the attention they have long devoted to the natural history of Cheshire, and theirs are, consequently, the right and proper names to appear on the title-page. The work seems to us, however, to go considerably beyond the legitimate limits of the county in including in it the marine fishes within a line "from the Great Orme's Head in Carnarvonshire to Formby Point in Lancashire." We believe that the editor would have been well advised if he had restricted his observations to the land, fresh-water, and estuarine life, and thus rendered a second volume unnecessary, which would have been a great advantage in many ways. By omitting such quite unnecessary matter as the Wild Birds' Protection Act, set out verbatim at the expense of more than six pages; by judiciously squeezing the migration section; circumspectly condensing the interesting yet somewhat disproportionately long account of Dee as a wildfowl resort, and excising the repetitions in the bibliography, room could have been made for the contents of the second volume within the first. The map, which, under the present arrangement of the book, is relegated to the second volume, where it is very inconvenient, would have then been found in the volume the contents of which necessitate its more frequent consultation. The portrait of J. Fell, Esq., the estimable former chairman of the Lancashire Sea Fisheries, seems dragged into a work dealing exclusively with Cheshire, especially as he ceased to occupy that position in 1894, and his name does not, apparently, occur in the book.

Following a short introduction, in which the extinct and fossil species of the county are enumerated, full descriptive notices are given of each of the forty-six mammals which "occur or have occurred within recent years in Cheshire and its territorial waters." We read that the Scotch white hare which was introduced into Yorkshire has spread largely into Cheshire, and it will be interesting to watch how the rodent will be affected by this change to a locality where the warmer climate disperses the snow before the time for changing its protective winter-coat arrives. An interesting *résumé*, chiefly from the British Association report on the subject in 1887, is given of the herd of white cattle at Somerford Park, where it has existed for two centuries, and still consists of twenty-five head, and that now extinct at Lyme Park. As to the birds, the authors admit the title to a place on the list "during the present and last centuries" of 231 species, of which 112 breed, or "bred till recently," in the county, and among which the nightingale is included, "as there is no doubt that the bird has bred on some, at any rate, of the occasions when it has been observed"; but, as neither eggs nor nestlings have been seen, we may be permitted to continue to doubt the accuracy of the statement until better evidence be forthcoming. With regard to the

Somerford Cattle. From "The Vertebrate Fauna of Cheshire and Liverpool Bay." Edited by T. A. Coward.

pose of the kingfisher when hovering over a stream in quest of food, the authors assert that the long axis of its body is placed almost at right angles to the plane of the water. The bird no doubt adopts any attitude which it considers most appropriate to the occasion, but it is not by any means, in the writer's experience, the usual one, which is to hover hawk-like a score or so of feet above the stream, and like it remain perfectly stationary, just as it is represented in the figure by Harting in his "Recreations of a Naturalist," reproduced in NATURE of May 24, 1906. It is pleasant to read that the great crested grebe, one of our handsomest birds, is more numerous in Cheshire than in any other county, from which we may infer that, temptation notwithstanding, plumassiers' agents leave it unmolested. It is well known that this bird covers its eggs on leaving the nest during incubation with a mass of rotting and fermenting nesting material, and our authors seem to assent to the suggestion (of Seebohm) that the material is so placed that through the heat thereby generated incubation during the bird's absence may not be retarded. This idea is rather discounted by the fact that the material used is often neither rotting nor fermenting, and therefore without heat, but consists of fibres of reeds cut off from those within reach of the breeding bird's beak, and freshly teased out by it. The most remarkable bird in the list is Schlegel's petrel (*Œstrelata neglecta*), a wanderer from the antipodes, found dead in a field near Chester. Whence it arrived and how its dead body came where it was found are unexplained mysteries. Cheshire reckons in its reptilian and amphibian fauna the usual small number of forms common to nearly every other county in the country.

Mr. Johnstone's introduction to the section of the fishes, extending to thirty-nine pages, enters into many subjects valuable in another relation which seem to us foreign to the subject of this book, and which few would look for in an inland fauna. The majority of the fishes enumerated can hardly be claimed as belonging to Cheshire, which has only a snout of seaboard less than ten miles in extent, faced, besides, with a sandbank stretching seaward almost as far as the limits of its territorial waters. Of the 107 species enumerated, fifty-five are "very rare," and many are included on the scantiest authority. The list, for instance, opens with the sunfish, "once recorded from local waters," thereby meaning Southport! Other notes are:—"No occurrence of the mature fish in strictly Cheshire waters"; "on Welsh side of Dee"; "does not occur in territorial waters of Liverpool Bay." Then why insert these species? Those taken "once in Queen's Channel" and in "Crosby Channel" are surely game poached from Lancashire. By what right can species from "off the Mersey banks," "off the estuaries," or "mouth of Dee" be ascribed to Cheshire's "territorial waters"? And if "drifted eggs" of pelagic species detected in water of the bay be sufficient evidence for adding them to the Cheshire fauna, why not include the whole marine fauna of the Irish Sea? This shortcoming, except as we have indicated, detracts little from the unquestionable value of the major part of Mr. Coward's book.

Messrs. Witherby and Co. are to be highly congratulated upon the excellence of the work as a commercial product. A special word of praise is also due to the illustrations, the majority of them separate plates on fine-surfaced paper, every one excellent, several of quite charming bits of scenery, all admirably photographed and reproduced. By the courtesy of the publishers we are enabled to present "Somerford Cattle" as an example.

ACROSS YUNNAN.[1]

IN the present work the author gives an account of his last journey from the Yangtse to Yunnan-fu, and onward to Haipong and Hong Kong. It is edited by Mrs. Archibald Little, who accompanied him in his travels, and whose personal experiences among the Chinese have been recorded in her published works. The main interest of the volume lies in its bearing upon the great railway just completed, which links up the capital of Yunnan with the French colonial possessions in Cochin-China. The author, in following the route, points out the engineering difficulties that had to be overcome in building the line. It traverses a rough, mountainous region, alternating with rivers, low-lying, malarious swamps, and stony, sterile wastes, places where work had to be suspended owing to outbreaks of fever that thinned the ranks of the labourers.

The line from Tonking, in a distance of 263 miles, rises 8000 feet to the level of Yunnan-fu, by gradients of 2·51 feet in 100. It was to be opened officially on April 1, 1910, and the issue of the book was designed to be coeval with this event "as a tribute to

Lofty Stone Column, such as are common in Yunnan, and recall Cornish Crosses. Near Chao-tung-fu. From "Across Yunnan."

the French enterprise" on which the author touches so often with warm admiration in his pages. While the project of building a British line of communication to Yunnan-fu from Kunlung ferry remained in abeyance, M. Dormer, the energetic Governor of Cochin-China, pushed forward his scheme, which was at once passed by the French Chamber in 1905, and carried through with a promptitude deserving of all praise.

The completion of this trade-route involves a new factor in the problems of international commercial intercourse with western China, the advantages which may accrue falling at present to France. There are other existing lines of communication with Yunnan, but no railways, as the west river route, by which, after tedious marches, produce reaches Canton and Hong Kong. There is also that by the Yangtse. Some

[1] "Across Yunnan." A Journey of Surprises, including an Account of the Remarkable French Railway Line now completed to Yunnan-fu. By Archibald Little. Pp. 164. (London: Sampson Low, Marston and Co., Ltd., 1910.) Price 3s. net.

idea of the difficulties encountered by this route may be gathered from the author's experiences. Were it possible to construct a railway from Ichang, at the lower entrance of the Yangtse gorges, through to Yunnan-fu, produce would readily find markets at the treaty ports on the lower river. In 1872 the present writer ascended the gorges, and concluded from his survey that it would be impossible to utilise this section of the river for steam navigation. The late Mr. Archibald Little appeared to have confirmed this view when he made his memorable ascent in 1887.

The story of this journey is admirably told, and rendered all the more attractive by a series of well-chosen photographs. J. T.

DOES THE INDIAN CLIMATE CHANGE?[1]

ANYONE who has examined carefully the meteorological elements of any country, whether they deal with pressure or rainfall, will have noticed that the curves formed by plotting the values for consecutive winter or summer seasons, or even for whole years, present a very wavy appearance. A closer inspection of such curves brings out the fact that they are really of a composite nature, and are made up by the superposition of waves of long and short lengths.

Such curves indicate that the meteorological elements not only oscillate, about a mean value, rapidly and to a considerable extent in magnitude, in a short period of time of about three or four years, but that, in addition to these variations, there is another oscillation, or perhaps several others, occurring over very much longer periods.

It is the presence of the long oscillations which has given rise to the idea that climates are permanently changing. This is due to the fact that in many cases meteorological observations made in a homogeneous manner do not extend over a sufficiently long period of time to exhibit a complete wave or oscillation, and the conclusion of climate change is drawn incorrectly from the portion of the wave which is indicated.

The main difficulty met with in dealing with a long series of observations is that those made in the early days are not so accurate as those made more recently with modern instruments and methods. Thus while the data may show a change in the meteorological elements, such a variation may be purely fictitious, and due to either the instruments, the methods, the observers, or a combination of all three.

In the volume under notice attention is directed to the fact that since the year 1894 the monsoon in north-west India has indicated a very marked weakness, and the suggestion has been made that a permanent change in the climate of that region has taken place, due, as some believe, to increased irrigation or diminution in forests.

The question of the strength of the monsoons in India is of such great importance to the inhabitants of that country—for it means drought or plenty, according as the monsoon is weak or strong—that Dr. Walker, the director-general of Indian observatories, discusses the subject in considerable detail in this memoir. In the first portion of this work he describes the care he has taken to use only data, extending over a great number of years, which can be thoroughly trusted, the records being obtained from the same stations throughout the whole period of time considered. Each province is separately dealt with, and the rainfall tabulations and curves begin at the earliest year possible and end at 1908.

Without entering into the results from each area, the broad conclusions need here alone be summarised. Thus Dr. Walker states that

"although there is no proof of any permanent climatic change, there has been a tendency over a large part of north-west and central India for rainfall during the past thirty years (*a*) to increase to a maximum between 1892 and 1894; (*b*) to sink to a minimum in 1889; and (*c*) to improve slowly since that time. Over the remainder of India there do not appear to have been any progressive changes of importance."

Dr. Walker, in seeking the causes of this variation, remarks, in the first instance, that (*a*) and (*b*) negative any explanation which has irrigation as a basis, and that as the destruction of the forests on a large scale ceased about twenty years ago, the expected improvement in the rainfall during the last fifteen or twenty years does not agree with the actual facts.

Failing local causes for variation, he shows that the true explanation is to be found in the extra-Indian area. Thus he finds that in the Nile there was a rise to a maximum in 1892 to 1894, followed by a rapid fall to 1899, from which time until 1906 a deficiency has prevailed, while in 1908 a very great improvement occurred.

This comparison shows the close association between the monsoon rainfall and the height of the Nile, and suggests that they are both dependent on the Arabian Sea current.

He, however, goes still further afield, and utilises, in a practical manner, some of the results of the investigations which have been made in recent years at the Solar Physics Observatory, South Kensington. In the researches just mentioned, it was demonstrated that when in any year the pressure over South America was in excess, that over India was deficient, and *vice versa*. As low pressure over India means a good monsoon, and high pressure a weak monsoon, the close meteorological relationship between these two very distant countries becomes of great importance.

Dr. Walker states:—

"Further, it is an established fact that the monsoon rainfall in India tends to be abundant when pressure is high in the Argentine Republic and Chili, and low in the Indian Ocean: it shows a fairly close correspondence, therefore, with the excess of pressure in South America above the pressure at Mauritius."

Using the data for these countries, he shows that the favourable character of the extra-Indian conditions rose to a maximum in 1892, fell to a minimum in 1899, and has on the whole recovered since that time. Thus he writes:—

"There are valid reasons, therefore, for regarding these extra-Indian conditions as having largely determined the general character of the Indian rains."

The discussion of the question as to whether the climate of India changes leads him finally to the following inferences:—

(*a*) "The recent deficiency of monsoon rainfall in a large part of central and north-western India must be attributed to something abnormal in the larger movements of the atmosphere and not to human agency in India; (*b*) the deficiency has not lasted long enough to justify the conclusion that there has been a permanent change of climate; and (*c*) there are marked indications of a return to good seasons."

WILLIAM J. S. LOCKYER.

[1] Memoirs of the Indian Meteorological Department, vol. xxi., part i. "On the Meteorological Evidence for supposed Changes of Climate in India." By Dr. Gilbert T. Walker, F.R.S. (Simla, 1910.)

NOTES.

THE Physical Society of London announces that the Montefiore Electrotechnic Institute at Liége has instituted a "George Montefiore Levi" prize, which will be awarded every three years, the first award being in 1911. The value of the prize in 1911 will be 20,000 francs (800*l*.). It will be awarded for the best original work presented upon the scientific advance and on the progress of technical applications of electricity in every field. Popular works and simple compilations will be excluded. Works must be in English or French. The jury will consist of ten electrical engineers, five being Belgian and five from other countries. The latest date for receipt is March 31, 1911. Further particulars are obtainable from the secretary, Association des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, rue Saint Giles 31, Liége.

THE *Morning Post* of August 9 gives prominence to an account of experiments made by Mr. Armbrecht, of Duke Street, on the change of colour of sapphires and other precious stones by the action of radium. The observations are interesting, but the results obtained are by no means new. Nearly three years ago Prof. F. Bordas read before the Paris Academy of Sciences a series of papers in which he described investigations of the effect of radium and other rays upon various forms of crystallised alumina from clear sapphire to brown and opaque corundum and other precious stones. Colourless corundum was transformed into topaz by the action of radium bromide; the depth of colour of natural topazes was increased, and a similar effect was produced with faintly coloured rubies. Short abstracts of Prof. Borda's papers will be found in the seventy-seventh volume of NATURE, November, 1908, to April, 1908.

THE tenth International Geographical Congress is to be held in Rome during the week beginning October 15, 1911. The congress will be under the patronage of the King of Italy. An organising committee of a representative character is already at work under the presidency of the Marquis Raffaele Cappelli, president of the Italian Geographical Society. Commander Giovanni Roncagli, secretary of the Italian Geographical Society, is acting as general secretary of the committee. The work of the congress will be carried on in eight sections, namely:—(1) mathematical geography; (2) physical geography; (3) biogeography; (4) anthropogeography and ethnography; (5) economic geography; (6) chorography; (7) historical geography and history of geography; (8) methodology and didactics.

WE are glad to notice that the useful work of the extension section of the Manchester Microscopical Society is to be continued during the coming winter session. The purpose of this section is to bring scientific knowledge, in a popular form, before societies unable to pay large fees for lectures. In some cases a small fee is charged, but all money thus obtained is devoted to the expenses of the section. The work of lecturing and demonstrating is entirely voluntary and gratuitous on the part of the members of the society. The list of lectures from which secretaries of societies may choose includes some sixty-one subjects and the names of seventeen lecturers. Application for lectures should be made to the honorary secretary of the section, Mr. R. Howarth, 90 George Street, Cheetham Hill, Manchester, who will send a list of the lectures on application.

MR. OSCAR GUTTMANN, whose death occurred in Brussels last week from injuries received in a taxi-cab collision, was known both as a consulting engineer and a technical chemist. He took frequent part in discussions upon chemical and manufacturing topics at the meetings of the Society of Chemical Industry, and contributed occasional papers. The titles of some of these—*e.g.* "Novelties in the Explosives Industry," "The Manufacture of Smokeless Powder," and "The Chemical Stability of Nitrocompound Explosives"—illustrate the fact that Mr. Guttmann was an authority upon explosives. Other contributions dealt with the manufacture of sulphuric and nitric acids, and the author was the patentee of several devices for use in this and other industrial operations. In an interesting note upon the oldest document in the history of gunpowder, Mr. Guttmann directs attention to the use of this explosive as described in an illuminated MS., "De Officiis Regum," contained in the library of Christ Church, Oxford; and papers upon the early phases and progress of the sulphuric-acid industry also indicate that he was interested in the historical aspects as well as the practice of his professions. As an engineer, Mr. Guttmann had been charged with the design and construction of many large chemical and explosives works at home and abroad. His experience in the two branches of his calling was probably unique, and well qualified him to speak, as he did in an address delivered some three years ago, upon "The Works Chemist as Engineer." Mr. Guttmann was born in 1855, and became naturalised here in 1894. He was a member of the Institution of Civil Engineers, a Fellow of the Chemical Society, a Fellow and sometime vice-president of the Institute of Chemistry, and a member of the council of the Society of Chemical Industry. At the time of his death he was acting as one of the British jurors at the Brussels Exhibition.

THE arrangements for Section H (Anthropology) at the forthcoming meeting of the British Association have just been communicated to us. The preliminary programmes of other sections were stated in NATURE of July 28. In general ethnography, Mr. E. Torday will describe in Section H some of the tribes encountered in his recent exploration of the Congo area; Mr. Beech will deal with the Sok, of whose language he has made a special study during his residence in Africa; Mr. A. K. Newman, of Wellington, New Zealand, will discuss the origin and racial affinities of the Maori; and Miss Fletcher, of Washington, in an important communication, will deal with certain points connected with exogamy. Miss Fletcher will also contribute an account of recent developments in the study of anthropology in American universities. The archæology of the Mediterranean area will be dealt with by members of the British School at Athens. Dr. T. Ashby, director of the British School at Rome, will describe his excavations at Hagiar Kim and Mnaidra in Malta, and Messrs. Woodward and Ormerod a primitive site in Asia Minor. Prof. W. M. Flinders Petrie will give an account of his excavations at Memphis, and Dr. Seligmann will describe a Neolithic site in the Sudan. An important communication by Prof. Elliot Smith, which summarises the results of ten years' work, will discuss the racial affinities of the Egyptians from the earliest times. Among other archæological papers may be mentioned an account of the work of the Liverpool Committee for Excavation and Research in Wales, by Prof. R. C. Bosanquet, and a report on recent excavations at Caerwent, by Dr. Ashby; a communication from Mr. H. D. Acland will describe prehistoric monuments in the Scilly Isles, and Mr. Alexander Sutherland will give an account of the exploration of a Broch at Watten, Caithness. Friday, September 3, will be devoted to a joint meeting with Section L (Education),

in which intelligence tests in school children will be discussed. Among those who have promised papers written from the special point of view of the anthropological section are Dr. Lippmann, of Berlin, Dr. C. S. Myers, of Cambridge, Mr. W. Brown, of King's College, London, Mr. Burt, of the Liverpool Psychological Laboratory, and Mr. J. Gray. Dr. Kerr, medical officer (education) of the London County Council, Dr. W. H. R. Rivers, and others will take part in the discussion.

In the Long Vacation number of the *Oxford and Cambridge Review* Dr. A. Smythe-Palmer begins an elaborate study of the luck of the horse-shoe, "a veritable fetish, maintaining its reputation for magical potency with unabated influence into the twentieth century." He agrees that the belief in its power is largely based upon the mystical respect for iron, dating from its introduction as an innovation at the close of the Neolithic period; but he also supposes that in shape it is "only a rough-and-ready substitute for the old and long venerated symbol of the crescent," the use of which as a protection against the evil eye and other demoniacal influence is illustrated by numerous examples. He postpones to another article the further question of the mode in which the crescent acquired its magical significance.

In *Travel and Exploration* for August Mr. W. J. Clutterbuck publishes an interesting and well-illustrated account of the little known Great Lu-Chu Island, or, as the Japanese, who now occupy it, call it, Okinawa, the most important of the Lu-Chu group. He considers the islanders to be a finer race than their conquerors; the shape of the eye is different, being wide open and seldom oblique at the corners, while the women reminded him of southern Europeans. The distinguishing feature of the landscape is the tombs; and at a funeral he noticed the professional female mourners wailing as they marched along enveloped in sackcloth bags, the intention obviously being to conceal them, and thus avoid the unwelcome attentions of the ghost. The corpse is deposited in a tomb for three years, after which the bones are removed, washed, and placed in a highly ornamented earthenware urn, which has a curious resemblance to the house-shaped funeral urns found in other parts of the world, the intention in all cases being to provide a home for the spirit resembling that which the deceased occupied in this life.

Naturen for July and August (Nos. 7 and 8 of vol. xxxiv.) contains a well-illustrated account of the recent eruption of Etna, by Mr. A. Hoel.

We have to acknowledge the receipt of vol. xxxiii., No. 1, of Notes from the Leyden Museum, which, in addition to other articles, contains a continuation, illustrated by two coloured plates, of Mr. C. J. H. Biermann's account of the Homoptera of the Dutch East Indies.

The amphipod crustaceans of Bermuda and the West Indies, according to a memoir of 115 pages by Dr. W. B. Kunkel, published in vol. xvi. of the Transactions of the Connecticut Academy of Arts and Sciences, have apparently received but scant attention at the hands of naturalists. Recent collecting in Bermuda—by Prof. Verrill and others—has enabled the author to put matters on a very different footing. The most striking peculiarity of the amphipod fauna of Bermuda is its close affinity to that of the Mediterranean. Of forty-five Bermuda species, nineteen, or possibly twenty, are common to the Mediterranean. Eighteen out of the forty-five are peculiar to Bermuda, and only seven which are not endemic are unknown in the Mediterranean. In contrast to this abundance of European types, the presence of only nine species common to South and Central America is remarkable, especially in view of the fact that 93 per cent. of Bermuda decapods have been recorded from the West Indies and Florida Keys. "This paucity of forms from Central and South America probably has little significance, however, and is due simply to the small amount of collecting of Crustacea from these waters."

The difficult, if not indeed unanswerable, question as to the limitations of species and races is again raised by Mr. G. Dalgliesh in the case of the yellow-necked field-mouse. In this instance the writer maintains that this mouse ought to be regarded as specifically distinct from the ordinary long-tailed field-mouse (*Mus sylvaticus*) under the name of *M. flavicollis*, basing his arguments, not only on the physical differences between the two forms, but likewise on their distribution and their divergence in habits and disposition. It may be remarked in this connection that naturalists are by no means in accord as to the proper name for the yellow-necked form. Mr. Dalgliesh uses Melchior's *flavicollis*; but in his recently published "Faune des Mammifères d'Europe" Dr. Trouessart regards this term as a synonym of the true *sylvaticus*, and employs *wintoni* for the British form. On the other hand, Mr. Millais, as quoted by Mr. Dalgliesh, regards the British yellow-neck as a distinct local form of the Continental *flavicollis*, under the name of *M. f. wintoni*. Mr. Pycraft, again, in his "Guide to the British Vertebrates in the British Museum (Natural History)," alludes to the one form as *Apodemus sylvaticus* and to the other as *A. flavicollis*. The question of species or race is of infinitesimal importance, but the eccentricities in nomenclature are perplexing.

Much interest attaches to an article by Dr. Felix Oswald in the July number of *Science Progress* on the area termed by Dr. Sven Hedin the Trans-Himalaya, an area bounded on the north by the chain of lakes first discovered by the explorer Nain Sing, and on the south by the Indus-Tsan-po valleys. Throughout the area the trend of the mountains, as shown by a map, is quite distinct from the north-west and south-east direction of the Himalaya proper, this alone being held sufficient to justify Dr. Hedin's proposal of the term Trans-Himalaya. There is, however, much more than this, for, in the author's opinion, the Trans-Himalaya represents a block of ancient rocks thrown into folds at a very remote epoch, but at the date of the folding of the Tibetan plateau so intractable that they yielded to mountain-making force by first becoming fractured and then uptilted. If this be granted, "it follows that the natural continuation of the parallel ranges of the block now lies sunk beneath the Brahmaputra Valley, at the base of the great fault-scarp, to which the river flows in parallel alignment. Accordingly, this valley must be of the nature of a rift-valley or sunken trench, especially since the opposite (southern) wall of the valley lies parallel to the northern wall, and in like manner possesses an average height of 23,000 feet." In conclusion, Dr. Oswald traces a curious parallelism—which he believes to be more than accidental—between the structure of the Arabian-Armenian-Caucasian area on the one hand, and the Indian, Tian Shan, and Siberian region on the other, each having an anterior and posterior table-land separated by three systems of "waves."

The ninety-fifth volume of the *Zeitschrift für wissenschaftliche Zoologie* is completed by the number published on June 21. The papers which this volume contains deal, as usual, with a great variety of subjects, from pure

descriptive anatomy, as in the case of the elaborate memoir by Albert Bauer on the musculature of the water-beetle, *Dytiscus marginalis*, to the most minute investigations in cytology and protozoology. Heinrich Stauffacher's "Beiträge zur Kenntniss der Kernstrukturen" affords a beautiful example of the results to be obtained by modern cytological methods. Its chief interest, perhaps, lies in the demonstration of "nuclear bridges" (Kernbrücken) in the form of threads which connect the protoplasm of the nucleus with that of the cell body. W. Knoll, in the next memoir, deals critically with the question of the existence of such connections between karyoplasm and cytoplasm, and demonstrates their existence in the leucocytes of the human body. Amongst the other papers we have only space to mention the first part of C. Janicki's studies on parasitic flagellates, dealing with two species of Lophomonas found in the cockroach. The application of modern technique to the investigation of the Protozoa, as we hardly need point out, marks the commencement of a new era in the study of these organisms, revealing complexities of structure previously unsuspected, as the plates illustrating the remarkable genus dealt with by Janicki abundantly testify.

In the *Bio-chemical Journal* for June (vol. v., No. 4) Prof. Benjamin Moore and Dr. Stenhouse Williams detail experiments on the effect of an increased percentage of oxygen on the vitality and growth of bacteria. Of twenty-six organisms tested, two may be termed oxyphobic. These are the tubercle bacillus, which is not only arrested in growth, but is actually killed by a high percentage of oxygen, and the plague bacillus, which, though not killed, uniformly refused to grow in percentages of oxygen from 60 to 91. The staphylococcic group was also adversely affected, but the remainder, including the typhoid, dysentery, glanders, diphtheria, anthrax, and cholera organisms, was unaffected.

In the Bulletin of the Johns Hopkins Hospital for July (xxi., No. 232) Dr. John L. Todd contributes an excellent review of the recent advances in our knowledge of tropical diseases. He summarises the most striking additions to our knowledge of tropical medicine during 1909 as being (1) the discovery of infantile kala-azar in northern Africa; (2) the discovery of a new human trypanosome in South America; (3) the researches which have made it almost certain that the parasite of sleeping sickness undergoes a developmental cycle in the tsetse-fly which conveys it; and (4) the transmission of typhus fever to monkeys by the bites of body lice.

Important information with regard to the thyroid body and related structures is supplied in a paper by Mr. F. D. Thompson, just published in the Phil. Trans. A thyroid, thymus, and post-branchial body are developed in the gill-slits of elasmobranch fishes; but parathyroid and carotid glandules have not been observed. In teleostomous fishes, on the other hand, the only organs of this nature are the thyroid and thymus; but parathyroids make their appearance in amphibians and reptiles, in the former of which the post-branchial body is retained. In these groups the structure of the various glands of the thyroid type differs considerably; but in mammals such structural differences tend to disappear, and in certain circumstances the parathyroids may develop colloid vesicles, and thus become practically identical with the thyroid. The thyroid and parathyroids may accordingly be regarded as structures of diverse embryological origin, which remain distinct in lower vertebrates, but in mammals become intimately related and constitute a single apparatus.

So closely are fungi and bacteria often associated in their destructive action on plant tissues, that it is extremely difficult to determine which organism is taking the lead. Some botanists, including De Bary, Hartig, and A. Fischer, have expressed themselves very sceptical as to the possibility of bacteria penetrating living plant tissues; others, notably E. F. Smith in the United States and Prof. M. C. Potter, have offered results of experiments as proof that bacteria do pass into the living plant and penetrate through cell walls. The subject is fairly discussed by Prof. Potter in his presidential address delivered before the British Mycological Society, and published in their Transactions. In addition to other arguments, the author refers to his experiments upon the white rot of turnips, when the bacterium *Pseudomonas destructans* was not only isolated and re-inoculated on the host, but it was demonstrated that oxalic acid was produced by the bacterium, which acts as a toxin in plasmolysing and killing the protoplasm; he also states that subsequently penetration of the cell wall by bacteria was observed.

We have received from Mr. E. Reinders a copy of his paper on the "Sap-raising Forces in Living Wood," read before the Royal Academy of Sciences of Amsterdam, January 29. After a short discussion of the available evidence on the problem of the ascent of water in trees, he gives an account of his own experiments. His results are of interest, as supporting the view that water is raised by a pumping action of the living elements of the wood (a theory generally connected with the name of Godlewski), and the detailed description of Mr. Reinders's work will be expected with interest. Mr. Reinders proceeds from the fact "that manometers placed at different heights up the trunk behave quite independently of one another. Sometimes one shows a lower pressure, sometimes the other." This irregularity is assumed by Reinders to be due to the pumping action of the living elements in the wood, and he proceeds to test his view by killing the stem either by steam or by an induction shock. He found that "as soon as the trunk was dead the difference of pressure followed the same rule as would be expected to apply to a glass tube." In one striking case the stem was not killed, but so seriously injured that five days elapsed before the behaviour of the manometers became once more "as irregular as in living trees." It should be added that Mr. Reinders assumes that in dead trunks which can no longer act as pumps, water ascends "through other causes, *e.g.* with the help of cohesion."

In the June number of the *Agricultural Journal of the Cape of Good Hope* is an article on the dried fruit and raisin industry recently established in Cape Colony. Although no great amount of produce has yet been raised it appears that the local conditions are suitable for success, and when certain improvements are effected there is the prospect of supplying the needs of the colony and even perhaps of establishing an export trade.

We have received from the University of Wisconsin Agricultural Experiment Station several "Research Bulletins" devoted to subjects of scientific interest. A study was made of the physiological effect on the cow of the milking machine which is now threatening to supplant the cowman and the milkmaid. No bad effects on the general health of the animal or the state of the udder could be found, and for an ordinary dairy herd the machine worked very well. Whether it would give equal results in a high-class herd is not certain; but here the economic problem is

rather different. There still remain, however, a number of details in which improvements must be effected before the machine can be widely used. In another bulletin a description is given of an organism producing acidity in milk which appears to be closely related to *B. bulgaricus*, the characteristic organism of Yogurt, and to be widely distributed. Messrs. Hart, McCullum, and Humphrey continue their work on the functions of the mineral constituents of foods on metabolism in the animal, and show that the skeletal tissues can, if necessary, make good any deficiency of calcium and phosphorus in the ration. A low phosphorus intake was accompanied by a high calcium output in the urine.

THE use of more exact statistical methods in the investigation of agricultural problems has already led to interesting results, and is likely to prove of great benefit. Mr. Vigor recently discussed the relation between the reduction in area of wheat in England and the increased yield; his paper is published in the Journal of the Royal Statistical Society (part iv.). The reduction of the wheat area has been accompanied by a rise of the yield per acre in England as a whole, and improvements of the yield often appear to be greatest in those countries where the proportionate reductions of area have been greatest. Counties of low yields do not, however, appear to have been specially selected for a reduction of area. The yields of the various counties have shown a slight tendency to level up. By applying somewhat similar methods, H. Arctowski has, in Bulletin No. 7 of the American Geographical Society, mapped out the variations in the harvest in the United States during the decade 1891–1900. In general, very bad years in one region of the globe are years of excellent yield in another region, but the centres of compensation are not always found in the same regions nor is the compensation always exact; otherwise the supply would be constant.

THE Scotch Education Department has issued in connection with the Royal Scottish Museum, Edinburgh, two useful guide-books, "An Introduction to Petrography and Guide to the Collections of Rocks," published in 1909, and "A Guide to the Scottish Mineral Collection," published in 1910. Both are from the pen of Dr. S. J. Shand, who is in charge of the geological department of the museum, and both are sold for the modest sum of one penny. The guides have been specially compiled from the point of view of Scottish minerals and rocks, and are written in simple and, so far as possible, untechnical language, so as to appeal to the ordinary visitor unversed in these subjects. A few pages of the rock guide are devoted to a description of the collection of rocks of the Christiania district, which has, owing to Prof. Brögger's exhaustive studies, become classical in the science of petrology. Copious indices add to the usefulness of the books.

THE Tanami goldfield in Central Australia was discovered in the year 1900, but its development has been delayed by the scarcity of water and its situation in a remote part of the continent on the eastern frontier of Westralia. The general geographical and geological conditions of the goldfield are described in a short report by Mr. H. Y. L. Brown, the Government geologist of South Australia. (Government Geologist's Report on the Tanami Gold Country, Northern Territory of South Australia. Pp. 12; three maps. Adelaide: 1909.) Mr. Brown shows that the oldest rocks of the district belong to a series of slates, quartzites, and schists which, though pre-Cambrian, are stratified sediments. They have been invaded by plutonic rocks, including diorite and felsite, and covered by a series of limestones and dolomites, which he identifies as Lower Cambrian, and by quartzites, sandstones, and boulder beds, which he regards as probably Permo-carboniferous. There are widespread volcanic rocks, mainly basalts and volcanic ashes, which Mr. Brown assigns to eruptions ranging from Mesozoic to Cainozoic. His description of extinct craters suggests that some of the eruptions are of recent age. The gold occurs in lodes numerous in the pre-Cambrian sediments near the junction with the intrusive diorites, and also in "lode formations" in the igneous rocks. The mines are at present little more than prospecting shafts. The gold in the quartz is coarse, and where it occurs in the altered igneous rocks it is finely diffused. The widespread limestones and basalts produce a rich soil, and if adequate water can be obtained, the district will be valuable for pastoral purposes, while Mr. Brown regards the gold discoveries as promising and important.

IN a short article in the *Physikalische Zeitschrift* for August 1, Messrs. R. A. Houstoun and J. Logie direct attention to the fact that aqueous solutions of ferrous ammonium sulphate form a good filter for stopping heat rays. Alum solutions are, it is now known, no better than water in this respect. A glass cell, of inside thickness 3 cm., filled with a solution of ferrous ammonium sulphate, transmitted 75 per cent. of the light and 5·1 per cent. of the total radiation from a carbon glow-lamp; when filled with water it transmitted 90 per cent. of the light and 11·1 per cent. of the total radiation. The light, it should be stated, forms about 3 per cent. of the total radiation.

THE *Physikalische Zeitschrift* reproduces in its number for July 15 a communication made recently by Dr. F. Ehrenhaft to the Academy of Sciences of Vienna on an ultra-microscopic method of measuring the electric charges carried by small particles. The particles investigated were of the noble metals, and were produced by means of an electric arc between electrodes of the metal concerned. The air containing the particles in suspension was drawn into an ebonite enclosure in front of the objective of a Zeiss ultra-microscope placed with its axis horizontal, and illuminated from the side in the usual way. The enclosure contained the plates of a small condenser the axis of which was adjusted to be vertical. With the condenser uncharged, the time of fall of a particle through a measured distance in the field of view was observed; the condenser was then charged in such a direction that the particle ascended, and its speed again observed. Finally, the condenser was short-circuited, and the speed of fall again determined. Assuming that Stokes's formula for the resistance to the motion of a sphere in a viscous fluid holds for the particles investigated, the magnitudes of the electric charges carried by the particles come out smaller than 1×10^{-10} electrostatic units, a conclusion which does not accord with the view so generally held at present that the "atom" of electricity is $4{\cdot}6\times10^{-10}$ electrostatic units.

THE "Metzograph Grained Screen" takes the place of the ordinary cross-lined screen in photo-block making, and differs from it in giving an irregular grain and in requiring a shorter exposure. It does not produce its effect by stopping a large proportion of the light, as the cross-lined screen does, but by the lens-like action of the irregularities of its surface. It is produced by obtaining by sublimation a reticulated film on the surface of a glass plate, and then etching with hydrofluoric acid, the film acting as a resist. The screen was invented by Mr. James Wheeler about thirteen years ago, and as the little differences in its

manipulation, as compared with the lined screen, appear to have hindered its adoption in those cases where it offers especial advantages, Messrs. Penrose and Co., of 109 Farringdon Road, have just issued a booklet of instructions for its use. The pamphlet includes specimens of each of the ten degrees of fineness, suitable for work from large posters to the finest photogravure. The impressions show what fine results the screen yields, the chief peculiarity being the entire absence of the regular grain that some persons find so objectionable in the usual type of photo-block.

THE report of the senior analyst, Cape of Good Hope Government Laboratories, for the year 1909, contains some interesting reading. About three-fourths of the samples examined (3154 out of 3820) consisted of foodstuffs, beverages, and drugs; these call for no special comment except, perhaps, to question the utility of giving much analytical detail in a publication of this kind. The remainder of the samples reflect the character of the country: they are mainly mineral, agricultural, and toxicological articles. Gold assays are the most numerous amongst the mineral analyses, which include also the testing of coals, supposed platiniferous rocks, copper, iron, manganese, and tin ores, and supposed diamonds. Amongst the toxicological cases, one is especially noteworthy. A native woman had been poisoned with an indigenous bulb administered by a Kaffir "doctor," and it took four months to obtain proof that such bulbs (Hæmanthus) could produce the fatal effects in question. This delay was due to lack of knowledge concerning the local poisons, and the senior analyst urges that a research into the properties of the vegetable drugs and poisons of South Africa should be carried out systematically. At present, any such investigations are merely casual and incidental upon legal proceedings. The production of barley suitable for brewing purposes, and an investigation into the agricultural soils of the colony, are some of the other topics mentioned in a report which everywhere bears evidence of useful activity.

WE learn from the *Engineer* for August 5 that the first of the large caissons for the new foundations of the Quebec Bridge was launched at the works yard, near the bridge site, on July 8. This particular caisson is for the new north pier, and will be situated clear of the old pier, its centre being 57 feet further out from the shore. The new centre line of the bridge has been decided upon 15 feet west, or upstream, from the old centre, this alteration enabling the new superstructure to be 30 feet wider than the old. The new south pier will be 15 feet nearer the river centre, consequently the span will be 1758 feet instead of 1800 feet, as before. The rebuilding of the south pier presents many more difficulties than the north. The new south pier will occupy very nearly the site of the old, necessitating the placing of a caisson at the side of the existing one, and another across the end of the pair. Upon the three a new caisson, 79 feet by 180 feet, will be sunk. It is thought that the latter will be the largest ever constructed for this class of work.

A DESCRIPTION of the hydroplane *Miranda IV.*, built by Sir John Thornycroft, appears in *Engineering* for August 5. This boat is 26 feet long by 6 feet beam, and 2 feet 6 inches deep. In general outline she approaches very much to the shape of an ordinary boat, but the bottom is specially adapted to make her skim at high speeds. This arrangement gets over the difficulties of the original type of hydroplane, for at moderate speeds she goes through the water in a similar manner to an ordinary boat, and the variation of form necessary to make her skim is so small as not materially to affect her performance. When skimming, a small portion of the length amidships carries the weight, the rest of the boat being entirely clear of the water with the exception of a small length aft, which may have enough weight on it to make the boat stable longitudinally. The greater part of the bottom being thus clear of the water, frictional and other resistances are very greatly reduced. It is remarkable how small the disturbance of the water is considering the speed of the boat, which has exceeded 31 knots under somewhat unfavourable conditions. If the speed development of hydroplanes is found to follow the same law as that of torpedo boats, a hydroplane 52 feet long, 10 tons displacement, with a brake-horse-power of 950, should do 45 knots, and a speed of 60 knots might be obtained from a boat 110 feet long. Such development depends on the progress made with petrol motors of large power, and in a matter of this kind it is not wise to be in too great a hurry.

MR. WERNER LAURIE will publish shortly "The Black Bear," by Mr. W. H. Wright, author of "The Grizzly Bear."

MESSRS. D. APPLETON AND COMPANY are publishing immediately a new work entitled "Up the Orinoco and down the Magdalena," in which Mr. H. J. Mozans relates his travels to South American countries and across the Andes.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHS OF NEBULÆ.—Among the recent additions to the Royal Astronomical Society's collection of celestial objects are three of surpassing excellence taken by Dr. Ritchey with the new 60-inch reflector at Mount Wilson. The objects are the spiral nebulæ M. 51, M. 81, and M. 101, and these photographs bring out remarkable details as to their structure; the spirals of M. 101 are shown as broken up into soft, star-like condensations, like nebulous stars.

Dr. Ritchey has made a number of important improvements to his camera, and now uses two guiding eye-pieces, one on each side of the centre, in order to allow for any possible slight rotation of the field; a power of 800 is employed in the eye-piece. By using a smaller plate, only $3\frac{1}{2}$ inches square, the guiding star comes much nearer the centre of the field, that is, nearer the object under observation. He also has the plate carrier easily detachable, so that it may be taken off, and accurately replaced, *every half-hour* or so, to allow of re-focussing; this is done by using a knife-edge in the focal plane, and by such frequent re-focussing he keeps in the true focal plane within 1 or $1\frac{1}{2}$ thousandths of an inch. With an exposure of 7·5 hours, the photograph of M. 101 shows practically perfect star images, of which the smallest are only 1·6 seconds of arc in diameter, and Dr. Ritchey states that an exposure of $3\frac{1}{2}$ hours on the globular cluster M. 3 shows tens of thousands of star images which are only 1·15 seconds in diameter.

Photographs of parts of the Great Andromeda nebula, the Ring nebula in Lyra, and the Crab nebula were also sent, and are strikingly beautiful; much new light is likely to be thrown on the structure of these objects from the careful study of the negatives. A preliminary study shows that while in some (*e.g.* M. 101) the spirals are broken up into "nebulous stars," in others (*e.g.* M. 64, Comæ Berenices) they are apparently smooth; in M. 101 more than 1000 of these condensations have been counted. In the Andromeda nebula the central parts are apparently regular, with complicated dark rifts, and the spiral extends practically to the nucleus, but the outer branches contain great numbers of the "nebulous stars" (Monthly Notices R.A.S., vol. lxx., No. 8).

HALLEY'S COMET.—The Journal of the Royal Astronomical Society of Canada (vol. iv., No. 3) contains reproductions of fifteen photographs of Halley's comet, taken at the Dominion Observatory, Ottawa, by Mr. Motherwell, during the period May 3 to June 9, also reproductions from two photographs taken by Prof. Barnard, at Yerkes,

on May 5, the former of which shows a tail 20 million miles long.

Some extraordinary phenomena were observed at Victoria (B.C.) at about 7 p.m. (local M.T.) on May 18. The sun appeared to be in a state of rotation, emitting bright flashes of light at frequent intervals. These were probably unusual refraction phenomena, possibly produced by the interposition of cometary matter, and are recorded by an octogenarian, Mr. Helmcken, who has never seen similar phenomena before.

In No. 8, vol. lxx., of the Monthly Notices there are more than a dozen papers dealing with observations of the comet's position, its physical characteristics, and its spectrum.

The *Rivista di Astronomia*, No. 6, contains some ancient records of the comet, reproduced by Father Stein, one of which shows that Halley's comet was observed in Italy for about fifty days in 1066; it became lost in the solar rays on April 19, and reappeared, as an evening star, on April 24.

THE ACCURATE MEASUREMENT OF PHOTOGRAPHS.—In all photographic astronomical researches the results are more or less vitiated by errors introduced by the optical apparatus, including the eye and brain of the observer, employed in their reduction. To eliminate these errors, Prof. E. C. Pickering proposes, in Harvard College Observatory Circular No. 155, the employment of an automatic registering apparatus. Briefly, he suggests that the negative to be measured be passed between a constant illumination and the two balanced arms of a bolometer. As the star image, or spectral line, comes in between the heat source and the bolometer, some heat would be cut off, and the galvanometer in the circuit would show a deviation, which could be registered automatically. The galvanometer curve would thus become a record of the positions and intensities of the star images or the lines in the spectrum, and the method, especially for spectrum work, should certainly be tried by someone having the necessary bolometric apparatus or selenium cells at their disposal.

OBSERVATIONS OF PERSEIDS IN 1909.—In No. 31, vol. iii., of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo*, Herr S. Beljawsky describes the observations of Perseids made at Simëis on August 10, 11, and 12, 1909. The horary rates of the meteors observed on these three dates were 21, 60, and 17 respectively, and the positions of the radiants were 49°, +60° (5 obs.); 45°, +56° (15 obs.); and 43°, +55° (8 obs.), respectively. On August 11 there appeared to be another radiant at 62°, +16°, from which four meteors appeared to emanate, but the determination is uncertain.

RESULTS FROM THE MICROMETRIC OBSERVATIONS OF EROS, 1900.—During the opposition of Eros in 1900, a number of observers made micrometric comparisons between the planet and neighbouring stars. The results from a number of observatories have been reduced at Cambridge, and Mr. Hinks now discusses them in No. 8 of the Monthly Notices. The individual results agree generally, and give as the most probable value for the solar parallax 8·806″ ± 0·004.

WILD PLANTS ON WASTE LAND IN LONDON.

THE waste ground between Aldwych and the Strand has been colonised by a variety of plants, most of which show luxuriant growth. Many of the colonists have fruits or seeds adapted to wind distribution, as in the case of the winged fruit of the sorrel (*Rumex acetosa*), and of the plumed seeds of the hairy willow herb (*Epilobium hirsutum*) and French willow, or rose bay (*E. angustifolium*), by far the most conspicuous plant on the ground. It is of interest that *E. angustifolium*, which is absent in many of the waste places of London, occurs in the garden of Fountain Court, near the Strand. Among wind-distributed forms are also numerous Compositæ, the fruits of which are furnished with a pappus; these include the spear thistle (*Cirsum lanceolatum*), the groundsel (*Senecio vulgaris*) and its ally *S. viscosus*, the dandelion (*Taraxacem vulgare*), the butter bur (*Tussilago petastes*), and the Canadian fleabane (*Erigeron canadense*). Fruits and seeds of these various types might be blown with some readiness from neighbouring districts, or from one part of London to another.

To a varying extent, wind may be also efficient in carrying the seeds of hedge mustard (*Sisymbrium officinale*), London rocket (*S. irio*), which appeared in quantity after the Great Fire of 1666, and shepherd's purse (*Capsella bursa pastoris*); and the same is the case with chickweed (*Stelloria media*), white campion (*Lychius alba*), opium poppy (*Papaver somniferum*), a garden escape, frequently established in waste places, great plantain (*Plantago major*), pale persicaria (*Polygonum lapathifolium*), and scentless mayweed (*Matricaria inodorata*). In several of the above the seed is small or flattened, but it is not elaborately adapted to wind dispersal, and it may be questioned whether wind alone will account for the presence of these plants. A probable auxiliary exists in the sparrow, through the alimentary canal of which various seeds and fruits no doubt pass, and it is not unlikely that others become attached to its feet by means of the sticky London mud. It will be remembered that Darwin in the "Origin of Species" describes eighty-two plants as springing from the earth obtained from the feet of a single partridge. This method of distribution no doubt accounts for the presence of Dutch or white clover (*Trifolium repens*) and of two balsams, the pink-flowered *Impatiens glandulifera* and a white variety. The explosive fruit characteristic of this genus could certainly not shoot its seeds across the traffic of a London street. Possibly cats may be effective as agents of distribution in this case, and they may also account for the presence of cleavers (*Galium Aparine*), the hooked fruits of which would readily cling to their fur.

Among garden escapes, the marigold, nasturtium (=Tropæolum), wallflower, and a species of Prunus can be observed, as well as the opium poppy mentioned above; in connection with these, and with many of the wild species also, the neighbourhood of Covent Garden must be recalled.

The above list is by no means exhaustive, none of the grasses, for instance, having been mentioned; in one or two cases the identification had to be made from a distance and through the fence surrounding the waste ground.

AGRICULTURAL INVESTIGATIONS IN EGYPT.[1]

SEVERAL important events are chronicled in the current "Year-book of the Khedivial Agricultural Society." The scope of the society has recently been extended by the formation of a section dealing with farm animals, the object of which is to effect as much improvement as possible in the livestock of the country. Twenty stallions have already been distributed over the country, a number of selected cows have been acquired from which good stud bulls can in time be sent out, and a herd of buffaloes has been purchased with a view to the establishment of a heavy milking strain. In addition, an experimental farm of about 160 acres has been acquired near Cairo, and an arrangement has been effected with the State Domains Administration whereby a considerable tract of land is to be set aside for the raising of cotton or wheat seed of good quality. Finally, the society has directed attention to the diminished yield of cotton in proportion to the area sown. A committee was appointed to investigate the matter, and has already issued a report.

A considerable proportion of the year-book is taken up by Mr. Lawrence Balls's studies of Egyptian cotton. A detailed account is given of the results of a single cross made in 1905 between Afifi and Truitt Big Boll. The fourth generation is now growing, and, although the cross has no special economic value, and the results are in some ways incomplete, the record is a very valuable one, and throws much light on production of cotton varieties on Mendelian lines. The synthesis of a commercially useful cotton is a tedious business. Desirable characters are mostly dominant over undesirables, except where the

[1] The Year-Book of the Khedivial Agricultural Society, Cairo, 1909. Pp. xv+239. (Glasgow: The University Press, 1910.)

heterozygote is intermediate. Experimental difficulties are considerable. The plants are large, the flowers are not entirely self-fertilised, and some of the characters fluctuate considerably. Numerous pests attack the plants, including aphides, boll worm, and the cotton stainer bug, while two fungi, the "sooty mould" and "sore-shin," do great damage. An advantage, however, is that the cotton plant can be grown as perennial by simply cutting it back; in this way a further supply of seed from a particular plant can always be obtained if necessary.

Bees appear to be the chief agents in effecting cross-pollination, and they have to be excluded by mosquito nets covering the whole plant; there appears to be no wind-fertilisation. Before these nets were used, the preparation of self-fertilised seed was laborious and uncertain. Tissue-paper bags were employed for separate flowers, but a large proportion of the bagged flowers were shed. Now the operation is simplified. The flowers are castrated at 4 a.m. and cross-pollinated at 9 a.m. No bags are necessary if the other open flowers under the net are removed, except, of course, to cover the flower from the plant which is to be employed as the male parent.

The results are worked out in detail for a number of unit characters, and are plotted on curves. The data thus obtained are not only interesting in themselves as a study of a Mendelian problem, but are of distinct practical value for the cotton breeder.

Mr. Balls also writes on the general position of the cotton crop in Egypt, and gives a number of interesting historical details. It is not certain how or when cotton was first cultivated in Egypt. The old mummy cloths are of flax. Apparently no distinct allusion to cotton occurs until the time of Pliny, and there is nothing to show that cotton was cultivated before 200 B.C. No definite historical account can be given until the time of Jumel, a French engineer who, in the early years of the last century, recognised the possibilities of Egyptian cotton and made plans for extending and improving its cultivation. Importation of Sea Island cotton began in 1822 and went on for many years; Mr. Balls's view is that the present Egyptian cottons are hybrids between the brown-linted tree types associated with Jumel and Sea Island cotton. He further thinks that, for the future, it is necessary to evolve strains which mature early and are therefore not likely to suffer from the boll-worm, and which yield heavily, so as to compensate for the decreased production per acre which is now setting in.

This falling off in productivity makes a very pretty problem unlike any we know of elsewhere. Fifteen years ago the yields ran about 5·5 cantars per feddan; of late years they are only 4·5. There are, of course, many conceivable explanations duly set out in the report of the commission in the present volume and meriting further examination, but it is suggested that part of the trouble arises from a rise in the subsoil water following on the rise brought about in the Nile by the barrage schemes. On this question Mr. Lucas has something to say in the *Cairo Scientific Journal*. He tabulates the minimum water-level in certain wells, and shows that in these cases there has been a rise of more than 1 metre since 1894. Other factors have to be taken into consideration, and many further measurements will be required, but the scientific interest and practical importance of the problem can hardly be overrated.

Mr. Hughes gives an account of manurial trials on cotton, and we are pleased to see that he gives full mechanical and chemical analyses of the soils on lines accepted in Great Britain. A considerable amount of trouble is involved, but the results are of much wider value in consequence. Mr. Willcocks describes the insects injurious to stored grains, seeds, &c. In the *Cairo Scientific Journal* Mr. Fletcher describes an experiment in which maize was grown for ten days in soils heated, respectively, to 95° C. and 170° C., and which he considers inconsistent with the work of Russell and Hutchinson. Mr. Fletcher accepts Whitney's hypothesis that soils contain a toxin injurious to plants, but put out of action by heat, an hypothesis much too controversial to be discussed here. No account appears to have been taken of the marked chemical decomposition of soil substances at the high temperature of the experiment.

SCIENCE IN BENGAL.

THE Journal and Proceedings (new series) of the Asiatic Society of Bengal has become a veritable miscellany—a very doubtful improvement upon the old arrangement followed by the Society, of publishing papers on philology and archæology, natural science, and ethnology, in three distinct and independent "parts," and of relegating matters of domestic and colloquial interest to the Proceedings.

The latest issues (Nos. 5–11 of vol. iv.) include thirty papers, in which Hindu mythology, numismatics, natural history both of the formal and of the discursive kind, archæology, geography, higher mathematics, lists of Oriental MSS., botany, epigraphy, and Indian history keep the strangest and most bewildering company with fragments of chemistry, philology, and geology, and with obituary notices and other domestic records.

Many of the papers deal with speculations rather than with matters of verifiable fact, and of these one of the most reasonable and most generally interesting is that by Mr. G. R. Kaye, on the use of the abacus in ancient India. The author examines, and expresses himself far from satisfied with, the evidence offered in support of the belief that the abacus was used in India in ancient times; and he is not at all disposed to accept without question the view that the Arabs borrowed their notation, which forms the basis of the science of arithmetic, from the Hindus.

The noteworthy papers on natural science are three in number. In one, Dr. N. Annandale describes a recent Himalayan species of a Psychodid fly of the genus Diplonema, a genus that "appears to have been known hitherto from three Tertiary species which occur in Baltic amber and from one Quaternary form in fossil copal." Another paper, by Mr. P. Bruhl, on recent plant immigrants into Bengal and Bihar, is a laborious compilation of considerable value, although, as the author includes cultivated plants as well as weeds, the title is a little disappointing; 234 phanerogams are enumerated and classified according to their systematic position and their land of origin, the result showing that 54·7 per cent. of them have been derived from America. Of these 234 species, however, only thirty-seven are entirely wild, and so are true, unassisted (or, at any rate, not deliberately introduced) immigrants; all the others are either cultivated or can be traced to cultivation. A third paper, by Colonel Prain and Mr. Burkill, describes seventeen new species of yams from China and neighbouring countries to the south, the descriptions, which are in Latin, being models of clearness and concisencss.

The twenty-first instalment of the late Sir George King's "Materials for a Flora of the Malayan Peninsula" is happily distinguished by appearing as an independent "extra number" of the old series of the Society's journal. It treats of the Gesneraceæ and Verbenaceæ. Of the former order, 131 species, distributed in twenty genera, are described by Mr. H. N. Ridley; of the latter order, seventy-two species, belonging to fifteen genera, are dealt with by Mr. J. S. Gamble.

We have also received Nos. 5–9 of the second volume of the new Memoirs of this society.

No. 5 of these is a most learned and interesting treatise (which is to be continued) on Mundari poetry, by Father J. Hoffmann. The Mundas are one of the aboriginal tribes of Central India, and a large remnant of them is isolated in the hills of Chota Nagpur. "Their world is a narrow circle of villages hidden away in forest-clad mountains . . . and they are quite content to leave . . . its wonders to such races as may care for them. Their only desire . . . is to be left alone." They are entirely illiterate, and know nothing about any alphabet. If they did, one would suggest that the sixteenth ode of the second book of Horace might be translated into their language as a good reflection of their views of life; but their own poetry, which is meant to be sung, does not touch the skirts of divine philosophy: it deals with the simplest of perennial themes, such as first love, friendship, maiden vanity, the pleasures of the chase, and the goodness of the good old customs, or, on the other hand, blighted affection, the pangs of hunger, and the terrors of the jungle. According to Father Hoffmann, their simple lyrics

are unrhymed, and have no pronounced rhythm, except such as is imparted by the singer; and they consist for the most part of repetitions of some simple idea, but are saved from monotony by a tricky use of synonym and metaphor. As the vocabulary is limited, the Munda poet uses the utmost freedom in detaching a required word from its associations; for instance, in order to harp upon the idea of the perfume of flowers, the word that in ordinary conversation implies an ancient and fish-like smell may be used as a synonym with perfect propriety. But this poetic licence never breaks the bounds of decorum: "Of the hundreds of songs which, after the day's work, resound over the whole country, evening after evening, not one is defiled by a lewd expression, or even by an indecent allusion."

No. 8 of these Memoirs is entitled "A Monograph of Sea-snakes," and its author would have done better had he considered that in this very fallible world nothing is ever gained by labouring to expose the mistakes—or supposed mistakes—of fellow-workers. To read this pretentious "monograph," one might suppose that the British Museum Catalogue of Snakes, the author of which is persistently gleeked and galled at throughout, was hardly worth the paper it is printed on. No doubt there may be errors in the catalogue, as there are in all the works of mortal men; but even were the errors great and manifold—and no one who uses the catalogue considers this to be the case—the work would still stand out as a comprehensive and critical account of our knowledge of the Ophidia, and a well-arranged storehouse of fact, to which all after-workers must be indebted, whether they choose to acknowledge their debt or not. So that when the author of this monograph states that his "views are substantially different from those held by 'Professor' Boulenger" (the distinguished begetter of the British Museum Catalogue), and further solemnly announces that "there are discrepancies between Mr. Boulenger's work and mine affecting questions of actual fact," the most easy-going critic is roused to attention.

The shattering "discrepancy of fact" turns in the main upon the question whether the posterior maxillary teeth of certain sea-snakes are grooved or not. The British Museum Catalogue recognises the genus Hydrophis as distinct from the genus Distira, because in the former genus the posterior maxillary teeth are not grooved as they are in the latter genus; but to the author of this monograph, using "a new lens of the very highest power and quality specially recommended for this work," it "became clearly revealed" that the posterior maxillary teeth in Hydrophis are "all grooved." In any case, the matter is of no very great importance, as every naturalist understands that the limits between species and genera are often not very sharply defined; but to test the case we removed the poison-fang and one of the posterior maxillary teeth of a well-preserved and authentic spirit-specimen of *Hydrophis latifasciatus*, and examined them side by side, not indeed with any "patent double million magnifyin' gas microscopes of hextra power" such as Mr. Sam Weller demanded in order to see through a flight of stairs and a deal door, but with an ordinary microscope. In the poison-fang the poison-canal is as plain as a diagram; in the small posterior tooth there is no trace whatever of any groove.

If, instead of holding up the British Museum Catalogue to reprobation, and adding grievous burdens to terminology, the author had given us some facts about the anatomy of sea-snakes, and had summarised what is known about the habits, food, and enemies of these animals, and the nature and mode of action of their venom, his work might have approached the standard of a monograph. As it stands, it is merely what is known as a revision of the subfamily—and an incomplete revision, because, among other things, the several genera are not fully defined, and are not properly referred to their respective authors.

We cannot leave these Memoirs without a short reference to No. 9, which contains a "Polyglot List of Birds in Turki, Manchu, and Chinese," by Dr. E. D. Ross. The author disclaims any acquaintance with ornithology, and apologises for undertaking such work "with nothing but linguistic equipment." The paper, which, with indices, occupies more than 100 pages, is divided into "Part i., Large Birds," for which the "generic" name is Qus, and "Section ii., Small Birds," for which the general name is Qucqac; 360 birds are included; some of them are specifically identified, others are identified in a general way, while others are merely treated after the manner of the commentator. An illustration of each of the three methods will show how far this dish of literary minutalia is likely to be of service to an ornithologist.

"30. *Qu:* ? The Cormorant: Manchu, *Kotan*; Chinese, *Tao Ho*. The 'Mirror' says: 'It somewhat resembles the wild swan and is grey in colour. Its beak is wide and its crop large. It fills its crop with water which it pours into rat-holes, and having thus driven out the rats eats them.' I am in doubt whether the swan or cormorant is intended here. *Qu* is the common Turki name for a swan."

"179. *Aqis Cikdaci:* The Chough: *Pyrrhocorax graculus*: Manchu, *Cinjiri*; Chinese, *Liao ko* [Giles's Dict., the blue grackle]. The 'Mirror' says: 'Colouration violet; red beak parting on the top of the head. A skilful singer with a very clear voice.'"

"336. *Ding-ding Qucqac:* A species of wagtail: Manchu, *Tukiyeri cecike*; Chinese, *Yao t'un ch'iao*. The 'Mirror' says: 'Over the eyelids are long ash-coloured feathers looking like eyebrows; short tail; always struts when walking."

Many other fearful wildfowl are exhibited, and all are fitted with tags of comment and reference, some of which call to mind the notes to Thackeray's delightful paradoy "Timbuctoo."

AUSTRALIAN AND ARGENTINE BIOLOGY.

THE third number of the Memoirs of the National Museum of Melbourne is devoted to descriptions by Messrs. Baldwin Spencer and J. A. Kershaw of remains of subfossil emeus and marsupials from King Island, Bass Strait, and, in a second paper, to a review of the existing species of wombat. As regards emeus, the authors find that Kangaroo Island, King Island, and Tasmania were severally inhabited by species distinct from *Dromaeus novae-hollandiae* of the mainland. Both the Kangaroo Island *D. peroni* (*ater*) and the King Island *D. minor* were darker than the mainland bird, the first being distinguished from the second by its less robust build. The Tasmanian emeu, which survived in numbers until at least as late as 1840, is still insufficiently described, but appears to have differed in colour from each of the other three species, and also laid eggs of a distinctive character.

With the exception of a Dasyurus, the marsupials from King Island are identified with existing species.

Turning to wombats, the authors state that the first specimen known to Europeans was secured on Clarke Island, Bass Strait, in 1797 (not by Bass), and taken alive to Sydney, this forming the type of Shaw's *Didelphys ursina*. All the early examples of wombats came, in fact, from the islands in Bass Strait, and the identification of the Tasmanian animal with the Bass Strait *Phascolomys ursinus* is shown to be erroneous. In addition to skulls and bones, it appears to be now represented in collections only by a couple of skins recently secured on Flinders Island, where it still survives. The Tasmanian species, for which the authors propose the name *P. tasmaniensis*, is intermediate in size between the large *mitchelli* and the smaller *ursinus*, but agrees in shape with the former; its general colour is grizzled grey, with light hairs inside the ears.

In the course of a long paper on the birds of the East Murchison district, published in the April number (vol. ix., part iv.) of the *Emu*, Mr. F. L. Whitlock gives an account of his discovery of the playing-grounds and nests of the yellow-spotted bower-bird (*Chlamydodera guttata*), illustrated by photographs. A peculiar feature of the species is that at the commencement of the breeding season several individuals sometimes resort to the same play-ground, where the adult males make a nuptial display. The dimensions of one play-ground were 7 by 5 feet. The foundation was a mass of twigs, which raised the floor of the inverted arch about 6 or 8 inches above the general level of the ground, the walls of the arch being some

18 inches in height and 6 inches in thickness, while the total length of the intervening run was approximately 25 inches. In this run were placed thirteen flakes of limestone, together with about the same number of small green pods and a few beans, but no feathers or shells. The nests, which were built of twigs and placed in casuarina trees near the run, each contained a pair of heavily scribbled eggs.

For several years past Messrs. Baldwin Spencer and J. J. Fletcher have been studying and describing a large collection of Australian earth-worms, but in many instances it has been found impossible to decide on the proper generic position of the species. Before the classification can be considered final, a large amount of anatomical investigation is essential, and this work is being undertaken by the scientific staff of Melbourne University. Four papers, two by Miss G. Buchanan, the third by Miss F. Bage, and the fourth by Miss J. W. Ruff, embodying some of the results of this work are published in vol. xxii., part ii., of the Proceedings of the Royal Society of Victoria. Miss Bage, who treats of the structure and arrangement of the nephridea, states that these organs are subject to great variation in the different groups, and will probably be found of great value for systematic purposes.

Among other articles on local natural history in the March issue (vol. i., No. 5) of the *Queensland Naturalist*, special interest attaches to one describing a visit paid by Mr. G. H. Barker in September, 1909, to the reserve at Gold Creek, where numerous kinds of birds were observed.

The writer of these notes has been favoured with a cutting from the Argentine journal *La Nacion* of April 15 containing an account of a newly discovered skull of the gigantic glyptodont Dædicurus, with the previously unknown dermal head-shield in position. The skull appears to have been found in association with the skeleton, thus making the fourth more or less nearly complete example of the bony framework of this gigantic species.

RAINFALL OF RHODESIA AND AUSTRALIA.

TO the Proceedings of the Rhodesia Scientific Association (vol. viii., part iii., 1909) the Rev. E. Goetz, S.J., contributes a very valuable discussion of the rainfall of Rhodesia, based upon observations at sixty-three stations. Fifty of these are in southern Rhodesia; the conclusions therefore apply more particularly to the country between the Zambezi and the Limpopo (long. 27°–33° E.). The tables contain monthly and yearly amounts from the actual observations. The longest series is for Hopefountain (nineteen years), and the averages at most of the other stations have also been reduced to this normal by the usual method. An annual rainfall map shows clearly that the amounts near the Portuguese territory vary from 45 to 30 inches, and decrease westwards to 20 inches; but to the north-west (north of the Zambezi) the unreduced averages increase to 30 inches and above. There are some closed areas of high rainfall in southern Rhodesia which, the author assumes, will probably disappear with the returns of a larger number of stations. The rainfall for seasons, and for short periods at some selected stations, is dealt with in considerable detail. There is also an interesting discussion of rain and drought cycles; the nineteen-year cycle, based on the periodic movement of the high-pressure belt, recently proposed by Colonel H. E. Rawson, seems (the author thinks) to promise good results.

Bulletin No. 4, issued by the Australian Commonwealth Bureau of Meteorology, includes, *inter alia*, tables of percentages and mean monthly and annual average rainfall for each colony and for Tasmania. These values are transferred to a map consisting of miniature "graphs," showing very clearly the mean monthly percentages and other details. One of the several useful appendices shows the hourly distribution of rainfall and frequency of showers in most of the capital towns for a year ending June 30, 1909. The text of the bulletin gives an interesting account of the broad features shown by the maps, viz. that nearly the whole of tropical Australia receives the bulk of its rains during the period of the year when the convectional action in the interior of the continent is at its maximum. In the central latitudes, although the monsoonal influence still predominates, the colder months are under the influence of **V**-shaped depressions which skirt the southern shores during the winter and spring seasons. In Western Australia the maxima occur in the early and mid-winter months over the whole of the western and southern districts. In the agricultural areas of South Australia the winter and spring maxima are very marked, but in the far north the monthly values are very erratic. The pronounced feature of winter rains over South Australia and the western part of Western Australia is maintained in the western slope districts of New South Wales, but is obscured over the Victorian areas south and east of the mountain ranges by the disturbing character of the country. The same peculiarities affect the central, western, and northern interior of New South Wales.

THE CHEMICAL SIGNIFICANCE OF CRYSTAL STRUCTURE.[1]

LARGE numbers of chemical substances occur on the earth's surface as definite geometrical forms bounded by plane faces; these polyhedral shapes are called crystals. Inspection of the crystal forms assumed by mineral substances shows that, roughly speaking, each crystalline substance affects some specific geometrical shape which is characteristic for the material; further that, whilst crystals of any particular mineral attain vastly different dimensions and are bounded by planes which vary greatly in relative area, one geometrical feature remains constant. The angles between corresponding pairs of faces on any two crystals of the same substance are the same, notwithstanding the existence of difference in size or in relative face magnitude between the two crystals. The constancy of interfacial angle amongst crystals of the same substance is a law of nature, and has been amply demonstrated by the very careful crystallographic measurements made by Tutton during the last twenty years.

It is, however, not essential to study mineral substances alone in order to obtain a knowledge of the laws governing crystal growth. Great numbers of laboratory products can be caused to crystallise by condensation from some fluid condition; thus the crystals of various alums exhibited were obtained by slow evaporation of aqueous solutions of these salts.

The examination of a crystal shows that many of its physical properties differ according to the direction in the crystal in which the property is determined; the hardness of crystals, the speed at which light travels through them, and many other properties, are commonly dependent on the direction in which the material is examined.

The dependence of crystal properties on direction indicates the most essential feature of the crystal to be a definite and orderly arrangement of its ultimate particles; this arrangement is referred to as the crystal structure. Further evidence that crystals possess an arranged structure is furnished by the observation that crystallisation is not necessarily a spontaneous process. Thus, on melting benzophenone and rapidly cooling the clear molten mass, the liquid state is retained for many hours at a temperature far below the normal melting point of the compound. But on inoculating the liquid with a trace of crystalline benzophenone, crystallisation immediately commences and rapidly becomes complete. The introduction of a small particle of crystalline or arranged material into the liquid mass provides a nucleus upon which the molecules are able to deposit themselves in a similar crystalline arrangement; the process thus started quickly becomes propagated throughout the entire mass. The lack of spontaneity in the process of crystallisation leads occasionally to quite unexpected results. Thus tetrahydroquinaldine has been known for many years, and has been prepared by numbers of chemists. It has always been obtained as a liquid, and has never been supposed capable of existing in the crystalline state at ordinary temperatures; even when cooled in liquid air it merely becomes a thick resin, and does not crystallise. But on dissolving a few drops of it in a little light petroleum, and cooling the solution thus obtained in liquid air, the tetrahydroquinaldine crystallises out; on transferring a trace of the crystalline material obtained to

[1] Discourse delivered at the Royal Institution on Friday, April 15, by Prof. William J. Pope, F.R.S.

the liquid substance at the ordinary temperature, the liquid mass is seen to immediately crystallise. This well-known substance, hitherto known only in the liquid state at ordinary temperatures, really exists in a more stable condition as a crystalline solid.

Many substances are capable of crystallising in two or more distinct crystalline forms, of which one is, in general, the more stable at any particular temperature. The physical properties of the several crystalline modifications of any one substance are quite distinct and characteristic for the particular crystalline form, and in many instances even the colours of the several modifications are different. An example of this is afforded by pouring boiling water into a beaker coated with cuprous mercuric iodide; the brilliant scarlet crystalline form, stable at ordinary temperatures when heated in this way, becomes converted into another crystalline modification which is nearly black. The change is a reversible one, and the differences between the properties of the two crystalline modifications are to be attributed to differences in the mode of arrangement of the molecules in the two cases; the two modifications, in fact, possess different crystalline structures.

Although vast numbers of observations, such as the preceding, lead to the conclusion that crystals are arranged structures, it is not essential that the crystal should be a solid substance; during recent years large numbers of crystalline liquids have been discovered. On allowing melted cholesteryl chloride to cool rapidly, a brilliant display of interference colours is seen, owing to the particles of the substance assuming crystalline or orderly arrangement, whilst still retaining the liquid condition.

Having very briefly reviewed some of the many reasons for concluding that crystals are structured edifices, the nature of the architecture which they exhibit may now be considered. All the properties of crystalline solids harmonise with one simple assumption as to the manner in which the parts of the structure are arranged; this assumption is that the structure is a geometrically "homogeneous" one, that is, a structure the parts of which are uniformly repeated throughout, corresponding points having a similar environment everywhere within the edifice. The assumption of geometrical homogeneity as the characteristic of crystalline solids leads at once to the great problem solved by the crystallographers of the nineteenth century. This consisted in the inquiry as to how many types of homogeneous arrangement of points in space are possible, to the study of those types and to their identification, in symmetry and other respects, with the known systems into which crystalline solids fall. This work was commenced by the German crystallographer Frankenheim in 1830, and completed by the English geometrician Barlow in 1894. Briefly stated, the final conclusion has been attained that 230 geometrically homogeneous modes exist of distributing material, or points representing material throughout space, and that these 230 homogeneous types of structure, the so-called homogeneous "point-systems," fall into the thirty-two types of symmetry exhibited by crystalline solids. Models of a number of homogeneous point-systems illustrating some of these types are exhibited.

It is, however, obvious that the limitation of the possibilities of solid crystalline arrangement to 230 types marks but one stage in the determination of the nature of crystal structure, and throws no direct light on the relation between crystal structure and chemical constitution. Although by the end of the nineteenth century we had learnt that corresponding points of the units of crystalline structures form homogeneous point-systems, the great problem still remained of determining what are the entities which become homogeneously arranged, for what reason they become so arranged, and in what way the conclusions drawn by modern chemistry are reflected in crystal structure. This problem was a legacy to the twentieth century, and it now remains to indicate briefly the extent to which it has been solved and the results of chemical importance which have accrued during its investigation.

The problem may be most easily visualised in connection with some comparatively simple case, that, for instance, presented by the crystalline forms assumed by the elements themselves. It is generally admitted that an elementary substance consists of identical atoms, each of which acts as a centre of operation of attractive and repulsive forces. In a solid crystalline structure the atoms are obiously not free to travel through the mass, each, if not indeed fixed to a particular spot, being retained within a certain minute domain; each of these domains must be regarded as possessing a centre which marks the mean position of the atom.

The crystalline condition of an element may consequently be defined as one of equilibrium between forces of attraction and repulsion emanating from or referable to a flock of points homogeneously arranged in space, that is to say, conditions, the space occupied by a crystalline element, a homogeneous assemblage of identically similar atoms, may be partitioned into identically similar cells in such a manner that the boundaries of a single cell shall enclose the entire domain throughout which a particular atom exercises predominant influence. Since it is postulated that every point in the space is subject to the dominating influence of some next neighbouring atomic centre, it follows that the cel fit together so as to occupy the whole available space wit out interstices. Nothing is here said about the shape the cells; but since, in the case of an elementary sul stance, the atomic centres are all alike, so too will b the cells. Before proceeding to discuss the actual shapes of the cells referred to, it will be convenient to illustrate

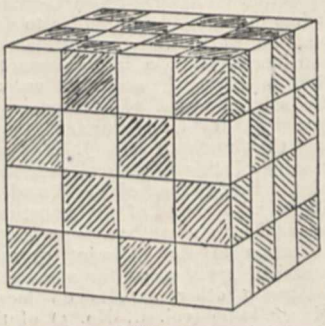


FIG. 1.

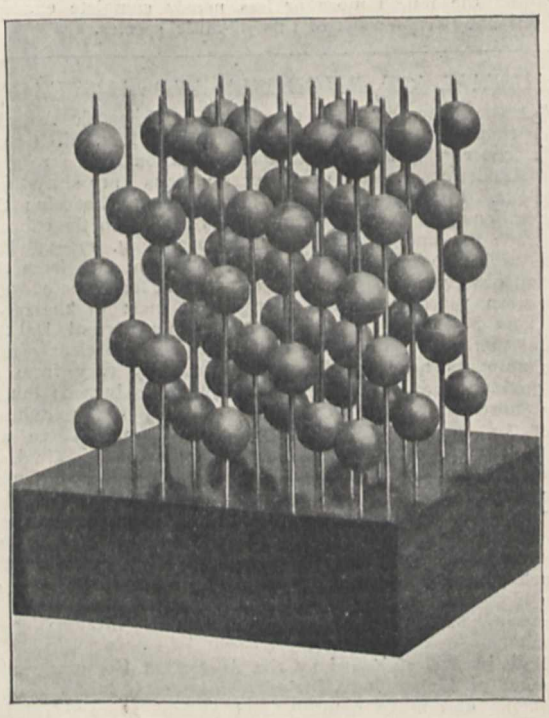


FIG. 2.

more graphically the mode of treating the problem which is here introduced with the aid of a particular point-system connected with the crystalline structure of elementary substances.

The point-system in question may be derived in the following manner. Space is first partitioned into cubes by three sets of parallel planes at right angles to one another (Fig. 1); a point is then placed at each cube corner and at the centre of each cube face. The cubes of the partitioning, having served their purpose, may now be removed,

leaving one of the 230 types of homogeneous point-systems (Fig. 2). Imagine, next, that each point of the system expands uniformly in all directions until it touches its neighbours; a system of spheres packed together in contact is thus obtained (Fig. 3), and, on examination, it is found that no way exists of packing these equal spheres more closely together than the one thus derived. The system is therefore termed the cubic closest-packed assemblage of equal spheres, and, being derived in the manner described, still retains the high symmetry of the cube; the fragment shown, in fact, outlines a cube. Three directions at right angles in it, those which are parallel to the three cube edges, are seen to be identical in kind; this identity in kind in the three rectangular directions a, b, and c is conveniently expressed by the ratio $a : b : c = 1 : 1 : 1$.

On removing spheres from one corner of the cubic closest-packed assemblage of equal spheres a close triangularly arranged layer is disclosed, and, by similarly treating each corner of the fragment of assemblage, the cube outline gives place to one of octahedral form. The assemblage is now seen to be built up by the superposition of the disclosed triangularly arranged layers, the hollows in one layer serving to accommodate the projecting parts of the spheres in adjacent layers. When this operation is

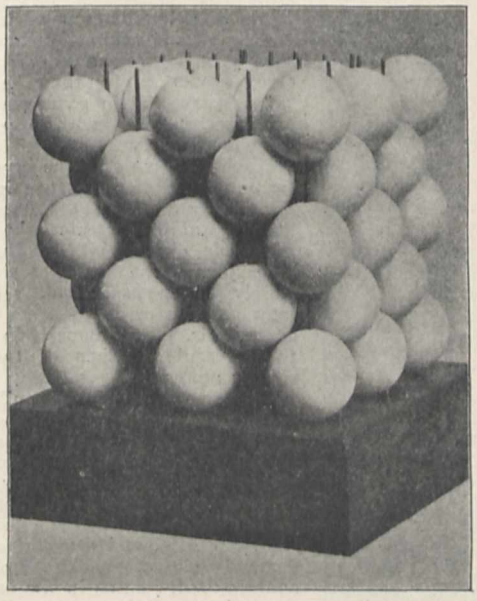


FIG. 3.

performed it is perceived, however, that two ways of stacking the layers homogeneously are possible. The first of these, in which the fourth layer lies immediately over the first, the fifth over the second, and so on, yields the cubic closest-packed assemblage. The alternative mode of stacking, in which the third layer lies immediately over the first, the fourth over the second, and so on, exhibits the same closeness of packing as the first, but possesses the symmetry of the hexagonal crystal system; it is accordingly termed the hexagonal closest-packed assemblage of equal spheres (Fig. 4). Examination of the hexagonal assemblage shows that the horizontal directions, in the planes of the layers, are not identical in kind with vertical directions perpendicular to the planes of the layers. Corresponding dimensions in these two directions, a and c, are in the ratio of

$$a : c = 1 : \sqrt{(\tfrac{2}{3})} = 1 : 0{\cdot}8165.$$

The final step in the treatment of the closest-packed assemblages of equal spheres consists in converting them into the corresponding assemblages of cells fitting together without interstices which have been already mentioned; it may be carried out in these, and in all other cases, by causing the component spheres to expand uniformly in all directions until expansion is checked by contact with the expanding parts of neighbouring spheres. The cubic closest-packed assemblage then becomes a stack of twelve-sided polyhedra, rhombic dodecahedra, which are so fitted together as to fill space without interstices. It is now seen that the even rate of expansion from each point of the original point-system which gives rise to the closely packed stack of rhombic dodecahedra symbolises an even radiation in all directions of the forces of which the atom is the centre of emanation. On applying the same operation of expansion to the spheres present in hexagonal closest-packing, each becomes converted into a dodecahedron, although of symmetry different from that of the rhombic dodecahedron. In each of the two cases the system exhibits the important property that, with a given density of distribution of the centres, a maximum distance prevails between nearest centres; these two systems thus represent the equilibrium arrangements of the postulated forces of repulsion exerted between near centres, the repulsions between more distant ones being neglected.

It will be sufficiently evident from what has been said that the function of the spherical surfaces in the closest-packed assemblages of spheres, as representing crystal structures, is merely a geometrical one; these surfaces are employed only as so much scaffolding by the aid of which may be derived arrangements exhibiting a maximum

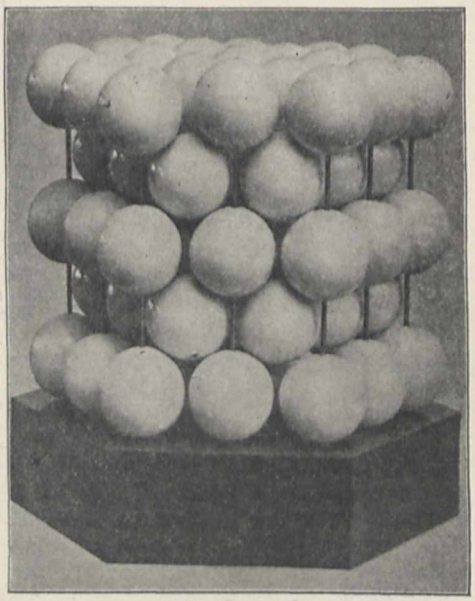


FIG. 4.

number of equal distances between neighbouring centres, and no physical distinction is to be made between portions of space lying within the spheres and portions forming part of the interstices between them. Insistence on this point is necessary, because many investigators have made use, quite illegitimately, of spheres for the representation of atomic domains, piling the spheres together in what they have termed open packing; this term seems to imply that some physical difference can subsist between the portions of space lying within the spheres and those lying without. The one kind of space is apparently regarded as susceptible to atomic influence in some sense not exhibited by the other. To state this view in any definite manner probably suffices to demonstrate its superficiality; the question of ascertaining what proportion of the total space is available for atomic occupation by the use of assemblages of spheres does not arise, because the spheres used are solely the geometrical instruments for producing equality amongst the atomic distances, and so determining the prevailing equilibrium conditions.

So far as the inquiry has been carried, it would seem that the elements should crystallise either in the cubic or the hexagonal system, and that in the latter case corresponding dimensions in the horizontal and vertical directions should be in the ratio of $a : c = 1 : 0{\cdot}8165$. The facts are summarised in Table I.

TABLE I.—*Relation between Crystal Form and Molecular Complexity.*

Crystal system	Elements	Number of atoms in molecules of compound inorganic substances					Organic compounds
		2	3	4	5	More than 5	
Cubic	50	68·5	42	5	12	5 8	2·5
Hexagonal	35	19·5	11	35	38	14·6	4·0
Tetragonal	5	4·5	19	5	6	7	5·0
Orthorhombic	5	3·0	23·5	50	36	27·3	34·0
Monosymmetric ...	5	4·5	3	5	6	37·3	47·5
Anorthic	0	0	1·5	0	2	8	7·0
Number of cases summarised in each vertical column ...	40	67	63	20	50	673	585

The proportion of substances crystallising in each system is stated above as a percentage.

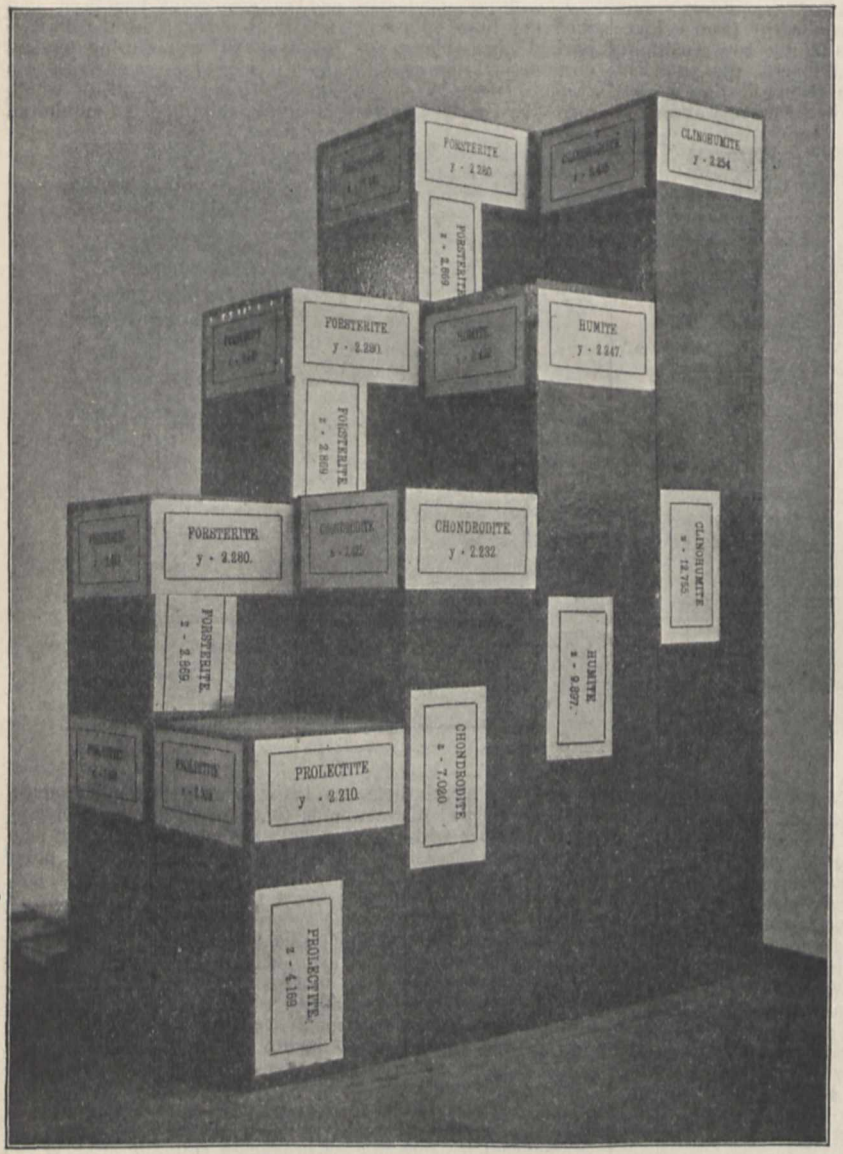


FIG. 5.

Of the elements which have been crystallographically examined, 50 per cent. are cubic; their crystal structure is simulated by the cubic closest-packed assemblage of equal spheres. Another 35 per cent. belong to the hexagonal system, and that these are correctly represented by the hexagonal closest-packed assemblage of equal spheres is indicated by the fact that for the hexagonal elements the ratio of corresponding dimensions in the horizontal and vertical directions approximates to the value $a : c = 1 : 0{\cdot}8165$, deduced for the model assemblage.

The task of accounting for the 15 per cent. of the crystalline elements which have been examined and found to crystallise in systems other than the cubic or hexagonal still remains. A little inspection shows that the crystal forms of these elements in every case approach very closely to one or other of the two of highest symmetry, namely, the cubic or the hexagonal; one example of this will now suffice. The values of corresponding dimensions in three directions in space for the monosymmetric form of the element sulphur are given by the axial ratios $a : b : c = 0{\cdot}9958 : 1 : 0{\cdot}9998$, $\beta = 95° 46'$. The slight departure of these dimensions from the corresponding values for the cubic closest-packed assemblage, in which $a : b : c = 1 : 1 : 1$, $\beta = 90°$, at once suggests that the monosymmetric modification of sulphur is derived from the latter assemblage by some minute distortion. Such a distortion indicates a very trifling departure from uniformity in the influence exerted in different directions from each atomic centre, and may either arise from some want of symmetry in the individual atoms or in a reduction of the symmetry caused by some grouping of the atoms; two or more atoms might thus be more closely connected in some way with one another than with other next neighbouring atoms.

Having shown that the crystalline forms of the elements are in complete harmony with the conception that crystal structures can be homogeneously divided into similar cells of polyhedral shapes approximating closely to the spherical, reference may now be made to some simple compounds, those, namely, in which the molecule consists of two dissimilar atoms.

The conception of the equilibrium of centred forces which has been shown fertile in the case of the crystalline elements can be immediately applied to the binary compounds; as before, each atom will be represented by forces emanating from a centre, and equilibrium will demand closest packing of the spheres used, just as in the previous case. The atomic centres will now, however, be of two kinds, and the question arises as to whether the domains of atomic influence to be described about them will be all of the same magnitude or whether two magnitudes of spheres must be employed, one for each element present. This question is difficult to answer by reference to the facts already reviewed above; probably the only indication which the latter afford in this connection is that closest packing of a considerable variety of different magnitudes would certainly be most unlikely to lead to the close similarity of crystal form observed as between the elements and the binary compounds. A direct answer is, however, provided as the result of investigating the crystalline forms of organic substances, to which reference will presently be made; this investigation has led to the discovery of a definite law which governs the magnitudes of the several kinds of atomic domain concerned in any crystalline compound substance. It is found that the magnitudes of the atomic domains in any crystalline compound are very approximately in the ratio indicated by the fundamental

valencies of the corresponding elements. Since the molecules of nearly all the binary compounds which have been crystallographically examined contain in the molecule one atom each of two elements of the same valency, the polyhedral cells from which a crystalline binary compound must be supposed built up are all, in general, of approximately the same magnitude. The fact that most binary compounds, like most elements, crystallise in either the cubic or the hexagonal system, represents one of the simple results of this law of valency volumes.

The binary compounds thus, in general, affect crystalline structures which are derived from the cubic or the hexagonal closest-packed assemblage of equal spheres; one-half of the spheres, selected homogeneously, represent atoms of the one element and the remainder atoms of the second element. The mode in which the necessary homogeneous selection may be made in the cubic assemblage, without altering the values of corresponding dimensions in three rectangular directions, is shown in a model.

The crystalline forms of the binary compounds are in accordance with what has been above foreshadowed. Table I. indicates that in geometrical respects the crystalline binary compounds closely resemble the elements; 68·5 per cent. of those examined are cubic and 19·5 per cent. hexagonal, the remaining 12 per cent. crystallising in systems of lower symmetry than these. The axial ratios, $a : c$, of all the hexagonal binary compounds known are stated in Table II.; all approximate closely to the value, $a : c = 1 : 0{\cdot}8165$, for the model hexagonal closest-packed assemblage of equal spheres.

TABLE II.—*Hexagonal Binary Compounds.*

		$a : c$			$a : c$
Beryllium oxide	BeO	1 : 0·8153	Cadmium sulphide	CdS	1 : 0·8109
Zinc oxide ...	ZnO	1 : 0·8039	Silver iodide.	AgI	1 : 0·8196
Zinc sulphide...	ZnS	1 : 0·8175	The ratio, $1 : \sqrt{(\frac{8}{3})}$		1 : 0·8165

In connection with the elements and binary compounds, it is noteworthy that the mode of treatment described appears practically to eliminate molecular aggregation of the atoms as a factor in determining the crystalline structure; that is to say, the distance separating two neighbouring atom centres is the same whether those atoms belong to the same or to different molecules. Another interesting fact is that, whilst the elements and binary compounds for the most part crystallise in the cubic or hexagonal systems, substances of greater molecular complexity rarely crystallise in these highly symmetrical systems; thus, of a great number of organic compounds examined, 2·5 and 4·0 per cent. only belong to the cubic and hexagonal crystalline systems respectively (Table I.). This observation is important as one of many indications that the cells into which the crystal structure of a complex compound are partitionable are not, in general, all of the same volume. Further investigation shows that the volumes of the polyhedral cells representing the atomic domains of the several elements present in a complex crystalline compound are governed by the law of valency volumes, to which reference has already been made. The correctness of this conclusion concerning the proportionality between the numbers expressing the fundamental valencies of the elements and the volumes of the corresponding spheres of atomic influence has been abundantly verified, not only by the laborious process of working out a large number of cases, but in several other ways which may be more rapidly indicated. The following are illustrations of the latter kind of verification.

Table III. states the composition and axial ratios, $a : b : c$, of a series of four crystalline minerals which differ in composition by the increment, Mg_2SiO_4; the sums of the valencies of the atoms composing the different molecular aggregates are stated under the heading W. The increment, Mg_2SiO_4, also occurs as the crystalline mineral forsterite, of which the axial ratios have been determined. It is evident that the ratio a/b has approximately the same value of 1·08 for all four members of the series, and that practically all differences in relative dimensions are expressed by the ratio c/b. On dividing the valency volume, W, by the corresponding value for c/b in each case, the quotients 11·7, 12·1, 12·3, 12·4, and 12·7 are obtained respectively for the substances prolectite, chondrodite, humite, clinohumite, and forsterite. The relative dimension, c/b, is thus roughly proportional to the sum of the valencies in this set of minerals. The comparison may, however, be made more accurately by including the changes in both relative dimensions, a/b and c/b, in the calculation, in the following manner. The "equivalence parameters" are the rectangular dimensions, x, y, and z, of a rectangular block having the volume W, and are in the ratio of the axial ratios $a : b : c$. The parameters x and y preserve almost constant values throughout the series, and addition of the increment, Mg_2SiO_4, leads to a practically constant increase of about 2·86 in the dimension z on passing from one mineral to the next in the series. The mineral forsterite also gives nearly the same x and y values as before, and its z value, 2·87, is equal to the differences between consecutive pairs of z values in the main series; these differences vary between 2·85 and 2·88. The axial ratios and equivalence parameters of forsterite can, indeed, be calculated with considerable accuracy from the data available for the series of four minerals.

TABLE III.—*The Humite Minerals.*

Prolectite ...	$MgSiO_4$	$2Mg(F,OH)$ ...	W = 22
Chondrodite ...	$Mg_3(SiO_4)_2$,	$2Mg(F,OH)$ ...	W = 38
Humite	$Mg_5(SiO_4)_3$,	$2Mg(F,OH)$ ...	W = 54
Clinohumite ...	$Mg_7(SiO_4)_4$,	$2Mg(F,OH)$ ...	W = 70

The increment is Mg_2SiO_4, namely, forsterite, with W = 16.

	Axial Ratios $a : b : c$	Equivalence Parameters $x : y : z$
Prolectite	1·0803 : 1 : 1·8862	2·389 : 2·210 : 4·169
		Diff. = 2·851
Chondrodite ...	1·0863 : 1 : 3·1447	2·425 : 2·232 : 7·020
		Diff. = 2·877
Humite	1·0802 : 1 : 4·4033	2·428 : 2·247 : 9·897
		Diff. = 2·858
Clinohumite ...	1·0803 : 1 : 5·6588	2·435 : 2·254 : 12·755
Values for the increment, forsterite.		
Oberved	1·0757 : 1 : 1·2601	2·449 : 2 277 : 2·869
Calculated	1·0823 : 1 : 1·2775	2·429 : 2·245 : 2·869

The relations here displayed may be rendered more obvious by a series of models (Fig. 5). Rectangular blocks having as the horizontal dimensions the x and y values, and as vertical dimension the z value, for forsterite, when superposed upon a similar set of blocks having the corresponding dimensions for prolectite, form a stack exhibiting the equivalence parameters of chondrodite; superposing on this a second set of forsterite blocks leads to a stack showing the equivalence parameters of humite, and on again repeating the operation, a stack with the dimensions of clinohumite results. From the numerical data and the models exhibited, it must be regarded as definitely proved that, in this series, the volumes appropriated by the constituent atoms are, in any one member, directly proportional to the valency numbers of the corresponding elements.

Another set of observations of a very convincing character, although of a totally different kind, is laid out in Table IV. Experimental determinations of the mole-

TABLE IV.—*Molecular Volumes of the Normal Paraffins at their Melting Points.*

—	W	Melting point $t°$	Molecular volumes: Observed at $t°$	Molecular volumes: Calculated as W×S
$C_{11}H_{24}$ ...	68	−26·5	201·4	201·96
$C_{12}H_{26}$ ...	74	−12·0	219·9	219·78
$C_{13}H_{28}$ ...	80	− 6·2	237·3	237·60
$C_{14}H_{30}$ ...	86	+ 4·5	255·4	255·42
$C_{15}H_{32}$ ...	92	+10 0	273·2	273·24
$C_{16}H_{34}$ ...	98	+18·0	291·2	291·06
$C_{17}H_{36}$ ...	104	+22·5	309·0	308·88
$C_{18}H_{38}$ ...	110	+28·0	326·9	326·70
$C_{19}H_{40}$ ...	116	+32·0	344·7	344·52
$C_{20}H_{42}$ ...	122	+36·7	362·5	362·34
$C_{21}H_{44}$ ...	128	+40·4	380·3	380·16
$C_{22}H_{46}$ ...	134	+44·4	398·3	398·00
$C_{23}H_{48}$ ...	140	+47·7	416·2	415·80
$C_{24}H_{50}$ ...	146	+51·1	434·1	433·62
$C_{27}H_{56}$ ...	164	+59·5	487·4	487·08
$C_{31}H_{64}$ ...	188	+68·1	558·4	558·36
$C_{39}H_{66}$ ...	194	+70·0	576·2	576·18
$C_{35}H_{72}$ ...	212	+74·7	629·5	629·64

Mean value of S = 2·970.

cular volumes of a long series of normal paraffins, made on the liquid substances at temperatures at which the materials are in physically similar conditions, are stated in column 4. Since the valency of carbon is four times that of hydrogen, it would be anticipated from the crystallographic conclusions previously drawn that each carbon atom should appropriate four times as large a space for occupation as one hydrogen atom; the quotient of the molecular volume by the valency sum or valency volume, W, should consequently lead to the same value, S, in the case of all the hydrocarbons. The mean value of S, namely, the atomic volume of hydrogen, is thus calculated as 2·970, and that it is constant within very narrow limits is seen on comparing columns 4 and 5, the latter of which states the product of the valency volume, W, by the value 2·970. The simple relation between the atomic volumes of carbon and hydrogen in the liquid normal paraffins indicated in the above table was recently pointed out by Lebas, and is abundantly confirmed by numerous series of determinations in addition to that now quoted. It is thus definitely proved that the law of valency volumes, first enunciated on the ground of the crystallographic evidence, holds rigidly in the case of these liquid substances.

Sufficient has been said to demonstrate that a method has now been devised by means of which the vast stores of accurate goniometric measurements collected by crystallographers during the past century can be interpreted, and that the requisite interpretation has in many cases already been given. Prof. Liveing, in a discourse delivered in this room nineteen years ago, suggested that crystalline forms are the outcome of the accepted principles of mechanics; the aid of these, and of these alone, has been invoked to show that crystalline structures result from the equilibrium of the attractive and repulsive forces radiating from the atomic centres.

RESULTS OF SOME RECENT INVESTIGATIONS ON MAGNETIC DISTURBANCES.[1]

AN examination of the times of beginning of the magnetic disturbance which occurred on May 8, 1902, as coincidently with the Mont Pelée eruption as can be determined, revealed the interesting fact that they were not the same all over the globe, being, in general, earliest at European stations. The times next progressed going around the earth eastwardly, the complete circuit being made by the disturbance in about 3½ minutes. This fact led to an examination of other similar disturbances, such as the one of January 26, 1903, and it was again seen that this one also progressed around the earth eastwardly, the time for the complete circuit being about 4 minutes.

Mathematical analyses were next made, and it was found that for both disturbances (May 8, 1902, and January 26, 1903) the systems of disturbance forces which it would be necessary to superpose upon the earth's own magnetic field were precisely of the same character as the earth's. In other words, were we to assume electric currents as constituting the disturbance systems, then, as is the case for the earth's field, the currents would have to circulate around the earth from east to west if they are positive ones, and in the contrary direction—from west to east—if they are negative or such as would be produced by moving negative charges. Furthermore, for both disturbances the electric currents would have to circulate chiefly in the regions above the earth.[2]

For the disturbance of May 8, 1902, there were a sufficient number of trustworthy determinations of the effect on the vertical intensity, and accordingly it was possible, by means of the analysis, to separate the external system of currents from the internal (below the surface) one; and then the surprising result revealed itself that the internal currents went in the same direction as the external ones, the latter being about three times the strength of the former. Hence, were we to suppose that the disturbance is caused by the motion of negative charges around the earth eastwardly, then the internal negative currents also go in the same direction, and accordingly they are not currents induced in the earth by the outer system.

If the earth's own magnetic field is likewise separated into an internal system and an external one, it is also found that for both systems the negative electric currents go in the same direction around the earth, viz. from west to east. The disturbance systems found above are therefore precisely similar in character to the earth's field. It should also be noted that the negative currents of the disturbance progress around the earth in the same way as did the times of beginning referred to above.

We have now become acquainted with the fundamental facts of observation pertaining to the simplest class of magnetic disturbances experienced by the earth—the sudden beginnings of magnetic perturbations, which, in accordance with van Bemmelen's suggestion, we will term for brevity "S" storms. Let us see what hypotheses are necessary for a *physical* explanation of the observed facts.

Prof. Kr. Birkeland, of Christiania, was the first to have attempted a definite physical theory to account for this class of disturbances, which he termed "equatorial perturbations," since they are most strongly developed in the equatorial regions, as judged alone from the size of the disturbance effect on the horizontal intensity. If the latter element suffered an increase, the disturbance was called a "positive equatorial perturbation," and if, on the other hand, the horizontal intensity was decreased, the disturbance was termed a "negative equatorial perturbation." The theory for these particular disturbances is only a part of the general "kathode-ray theory" developed by Birkeland and Störmer to account for all classes of magnetic disturbances and of polar lights, as set forth in their various papers, and especially in Birkeland's recent publication, "The Norwegian Aurora Polaris Expedition, 1902–3," vol. i., "On the Cause of Magnetic Storms and the Origin of Terrestrial Magnetism." It will be noted that it is even hoped to build up a general theory of terrestrial magnetism, and there is an intimation that the earth's magnetic periodic variations may likewise be among the consequences of kathode rays coming from the sun and entering the earth's field.

Without question, these important contributions of Birkeland and Störmer mark a distinct advance, and the student of magnetic science will find not only incentive, but also a wealth of material and many suggestive facts by looking over these very valuable researches. At present, however, their theoretical results and deductions must be regarded chiefly as *qualitative*. While it is made very plausible that the cause of our magnetic storms is to be referred principally to kathode rays originating in the sun and coming within reach of the earth's magnetic field, there are a great many questions left open which will require answering before full acceptance can be given to the theory in all its details. How the earth's own magnetic system is affected by a magnetic disturbance—whether the intensity of magnetisation is increased or decreased, if there are any after-effects, whether the currents within the earth are induced ones or are the same in direction as those outside, &c.—are but a few of the interesting and important questions to be solved.

It seemed very desirable, therefore, that someone should take up the investigation from an *analytical* point of view, viz. to take a typical magnetic storm and analyse the observed effects into spherical harmonic terms, so as to determine just how much is due to outside currents and how much to currents within the earth itself.

Birkeland concluded, from a general consideration of the effects of a magnetic disturbance on the vertical intensity, that all storms originate from without, and it is quite possible that, in the main, he may be right, but the conclusion cannot be accepted as invariably true without a detailed mathematical analysis of each particular case. In his first volume he accordingly proceeds on the assumption

[1] A summary of two papers presented respectively at the meeting of the Washington Academy of Sciences, February 17, 1910, and at the meeting of the Philosophical Society of Washington, April 9, 1910.

[2] See *Terrestrial Magnetism and Atmospheric Electricity*, vol. xv., pp. 9–30. In this connection it is also well to record that Dr. W. van Bemmelen, in his recent investigations on "The Starting Impulse of Magnetic Disturbances" (Proceedings of the Amsterdam Academy of Sciences, April 24, 1908), found the following important fact as applying to the Batavia magnetic observatory records, 1882–99:—"Taking no consideration of the slight introductory movement, 124 cases furnished for the duration of the impulse: in horizontal intensity, 4·5 min.; declination, 3·2 min; vertical intensity, 12·0 min. The duration of the vertical intensity movement is in general difficult to determine, as the decrease in this element keeps on mostly much longer. It is important to notice that the initial movement of D stops or is inverted, whilst of H the increasing movement keeps on."

that by far the greater part of a disturbance is due to upper electric currents, though quite likely, in a subsequent volume, he will consider the subterranean currents also. Since the observed quantities actually to be operated with appear to be resultant effects of both external and internal forces, it is very desirable that we should know just what proportion must be referred to one cause or the other. For this separation we require, however, a knowledge of the disturbances in the vertical intensity, and these are either difficult to determine with sufficient accuracy or are not to be had always at a sufficient number of stations, so that Birkeland was perforce compelled in his first treatment to assume chiefly external currents.

It was for these reasons deemed desirable to make known promptly the deductions derived from the mathematical analysis of certain typical cases of the class of "S" storms. We have now the means of applying the first decisive tests as to how far the Birkeland-Störmer theory will account for the facts.

There is a distinct advantage in treating, for the present, simply these sudden beginnings of magnetic disturbances for the reason that not only the time of beginning can be sharply determined, but, what is equally important, the actual magnitude and direction of the disturbance effect on any particular element can be most accurately determined. As the effects we are here especially considering do not extend, in general, over five minutes, we may readily scale off on the magnetogram the disturbance effect, being, without essential error, simply the difference between the ordinate to the curve at the point of beginning of the disturbance and the ordinate to the particular point of the disturbance considered. When, however, a magnetic storm extends over many hours, and even days, and one wishes to know the magnitude and direction of the disturbance at stated times, for example, every hour or half-hour, then what is called a "normal curve" must be drawn from which the disturbance ordinate is to be measured. This "normal curve" is supposed to represent the curve of magnetic variations which would have resulted had there been no disturbance; but to determine such a curve is far more difficult than is generally realised, and usually an arbitrary assumption of some kind must be made to derive it. Of such assumptions we are practically free in the disturbances considered.

Application of Tests.

The first fact of importance found from the analysis of the disturbance of May 8, 1902, was that the direction of flow of the negative electric currents, which could account for the external and internal magnetic disturbance systems, was the same for both systems. While the strength of the external system was about three times that of the internal, nevertheless, the internal currents were not the direct consequence of the outside moving negative charges, *i.e. they were not induced currents.* Instead, for both systems—outside and inside the earth—the flow of electricity was eastwardly around the earth for negative charges and westwardly for positive charges.

Having fixed the direction of flow of negative electricity, let us inquire now whether kathode rays coming from the sun will give the required direction. Birkeland, in his experiments on a magnetised terrella when placed in a Crookes's tube and subjected to a bombardment of kathode rays, observed, among other interesting phenomena, the formation, under certain conditions, of a ring of kathode particles which encircled the terrella in the magnetic equatorial regions. For an unmagnetised terrella there was no such ring. Störmer, from his mathematical investigations, found under what conditions a similar ring would be formed when kathode rays from the sun came within the deflecting influence of the earth's magnetic field. The ring results when electric charges enter a magnetic field perpendicularly to the lines of magnetic force, *e.g.* in the magnetic equatorial regions. It was on account of the possible formation of such an equatorial ring that Birkeland was apparently led to the adoption of his term "equatorial magnetic perturbation," and to refer its cause to such a ring.

If we apply, however, the well-known law according to which a negative charge would be deflected if entering the earth's magnetic field from without at right angles to the lines of magnetic force, it is unfortunately found that the deflection is to the west, and the moving negative electric charges would accordingly encircle the earth from east to west, hence opposite to what our mathematical analysis of the disturbance of May 8, 1902, and January 26, 1903, have shown must be the case to account for the observed disturbances.

Were we to assume, on the other hand, that the corpuscles are shot up into the earth's field instead of downwards, then those which struck the lines of magnetic force perpendicularly would, after successive deflections, circulate around the earth from west to east or eastwardly, and hence harmonise with the observed facts. Thus far, then, we should have to conclude that if the disturbances considered are to be referred to kathode rays deflected by the earth's field into more or less circular paths, the source of the kathode rays would have to be within the earth itself, and not without.

But if the radius of the ring of moving corpuscles is computed to conform with the time of propagation of the disturbance around the earth (about 3¾ minutes), it is found that the orbit would have to be distant from the earth's centre 580 times the earth's radius, or 3,700,000 kilometres, or 2,300,000 miles, and thus the possibility of a terrestrial origin of the kathode rays is likewise eliminated. Furthermore, if we calculate the intensity of the current which at that distance could produce the observed effects of the disturbances of May 8, 1902, and January 26, 1903, it is found to be 5,900,000 amperes. Now Birkeland says on p. 311 of his book:—"In the case of the greater storms, we found current-strengths that varied between 500,000 and 1,000,000 amperes, or even considerably more." Hence, to produce the comparatively insignificant magnetic disturbance effects here considered, by supposing a band of kathode particles circulating around the earth, would require a current at least six times stronger than that which Birkeland finds sufficient to account for the much larger storm effects!

The hypothesis was next briefly examined on which the disturbance effects considered might be referred to alterations in the electrical conductivity of the atmosphere and of the earth, either brought about by the secondary effects from bombarding kathode particles, viz. the formation of Röntgen rays, or, say, by the entrance into the earth's field of the penetrating radiation (γ rays of radium). The ionising effect and resultant alteration of electrical conductivity of the regions involved might either be due to the penetrating radiation from the sun or from the earth, if only *qualitative* results are considered. It is therefore at present not possible to state definitely whether the initial cause of the disturbance of May 8, 1902, was due to a terrestrial eruption or a solar one. First, further examinations will have to be made of the disturbances of May 20 and July 9, 1902, which were again closely coincident with the Mont Pelée eruptions. The electric-conduction hypothesis appears to satisfy, in general, the observed phenomena, and accordingly it is to be subjected to a further rigid examination. It seems also to explain why some of the disturbances take a westward path, although the majority of them go eastward.

Were we to suppose that the generated currents lie on a sphere of radius approximately equal to that of the earth, a velocity of the moving negative charges of 180 kilometres, or 110 miles per second, results, hence a quantity of the order of that for metallic conduction, or as found for the kathode rays from glowing electrolytes.

In conclusion, it should be stated that while it has been shown that the class of simple disturbances discussed in this paper cannot be referred to kathode rays in the way Birkeland and Störmer have supposed, it should be distinctly understood that this in no wise vitiates other portions of their theory, especially with reference to the larger and more complicated magnetic disturbances and to the origin and formation of polar lights. Before anything definite can be said as to the validity of these portions of their theory, it will be necessary to await the completion of a similar analytical treatment to that made for the "S" disturbances.

Such an analytical examination the writer has had under way for more than a year, and a preliminary statement of results was made at the meetings of the American Philo-

sophical Society and of the American Physical Society in April, 1909. Instead of drawing curves showing the variations in the diurnal ranges of the magnetic elements with solar activity, as is most frequently done, curves were constructed showing the effects of the magnetic disturbances experienced by the earth during the period April, 1906, to December, 1909, at the Coast and Geodetic Survey magnetic observatories, on the absolute values of the magnetic elements, and especially upon the intensity of magnetisation. This latter curve had been drawn for the first time; when it was compared with the curves showing the variation in solar activity, during the same period, as manifested by sun-spot frequency, sun-spot area, and calcium flocculi area, then the interesting result was obtained that "the intensity of magnetisation of the earth in general decreases with increase in solar activity."

In other words, the average or residual effect of magnetic disturbances, in general, is equivalent to that which would result by the superposition of a magnetic system opposite to the earth's own field, *i.e.* a demagnetising or induction system of magnetic forces. The north magnetic pole of this superposed system is, in general, in high south latitude instead of high north latitude, as is the case generally for the small "S" disturbances already discussed.

Hence for the larger *disturbance systems*, the electric currents which we may suppose to cause the effects would circulate around the earth, for negative ions, from east to west, *i.e.* contrary to the negative currents for the "S" disturbances, but this time in strict accordance with the direction in which a kathode ray coming from the sun would be deflected by the earth's magnetic field.

For these big disturbances, accordingly, the times of beginning, if they can be accurately obtained, will show an increase going round the earth westwardly. A good example is the most remarkable disturbance of which there is any record, viz. that of September 25 last. Here are the times for two sudden deflections at the beginning of the storm, as scaled by Mr. R. L. Faris, of the U.S. Coast and Geodetic Survey, from the horizontal intensity magnetograms of the five Coast and Geodetic Survey magnetic observatories:—

No.	Station	Greenwich mean civil time Sept. 25, 1909 Impulse First h. m.	Second h. m.	I.–II.
(1)	Porto Rico	8 37·7 ...	11 39·8 ...	−2·1
(2)	Cheltenham	8 40·9 ...	11 43·3 ...	−2·4
(3)	Baldwin	8 38·7 ...	11 41·1 ...	−2·4
(4)	Sitka	8 39·5 ...	11 39·8 ...	−0·3
(5)	Honolulu	8 42·7 ...	11 45·4 ...	−2·7
(6)	Mean of all	8 39·9 ...	11 41·9 ...	−2·0
(7)	Mean of Nos. 1, 2, 3.	8 39·10 ...	11 41·37 ...	−2·27
(8)	,, ,, 2, 4 ...	8 41·10 ...	11 42·60 ...	1·50
	Difference No. 7–No. 8	−2·00	−1·23	
	Mean Difference ...		−1·62	

The average latitude for the two groups Nos. 7 and 8 is, respectively, 32° N. and 39° N., and the average longitude 79° W. and 147° W. It is accordingly found that this particular disturbance was propagated from stations in the eastern part of the United States to stations in the eastern Pacific Ocean about two and a half times slower than was found for the simple "S" disturbances, hence roughly at the rate of 2600 miles per minute, against 6700 miles for the latter cases. It is not to be assumed at present, however, that the big disturbances progress over the whole earth at a uniform rate. Their motions appear much more complicated than for the "S" cases.

Accordingly, so far as the big disturbances in general are concerned, the kathode-ray theory of Birkeland and Störmer fulfils the test regarding direction of progression of the disturbance over portions of the earth, and as far as the direction in which the negative electric currents must, in general, go, as found from the preliminary analyses above mentioned. Whether the theory will bear the application of quantitative tests cannot be discussed now. The main thing is to have working hypotheses to which rigid tests can be applied.

Should the electric-conduction theory above proposed to account for the disturbances there considered find further confirmation, the way is opened to a possible corpuscular theory of terrestrial magnetism. On the basis of such a theory, a number of the puzzling features of the distribution of the earth's magnetism and of its variations can readily be explained. L. A. BAUER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

WE have received a copy of the "Livingstone College Year Book" for 1910. It contains college news, letters from old students detailing their experiences, a review of a year's progress in tropical medicine, &c. The training given at Livingstone College (a nine months' course) is designed to educate missionaries going to tropical countries in the elements of medicine, so far as they are required for the prevention of disease and the recognition and treatment of common accidents and diseases.

INDIANA UNIVERSITY, says *Science*, owns an experimental cave farm near Mitchell, Indiana, and has established a small laboratory there primarily for cave work. Cement pools have been placed inside and outside the caves, and give opportunities for breeding cave animals in the light and outside forms in the dark. The University offers a 100*l.* fellowship, in addition to a furnished cottage, to anyone who has had sufficient training to take up such work. Applications should be sent to Mr. F. Payne, Winona Lake, Indiana.

WE have received a copy of the handbook of the faculty of engineering at University College, London, for next session. The faculty includes the departments of mechanical, electrical, civil, and municipal engineering, and is intended to provide a systematic training for students who wish to devote themselves to engineering. It has been recognised by the Board of Trade as providing suitable technical training for marine engineers, and its courses also meet the needs of students who intend to enter for engineering appointments in the various public services. Prof. J. A. Fleming, F.R.S., is the dean, and Prof. J. D. Cormack the vice-dean, of the faculty.

THE governing body of the Imperial College of Science and Technology at South Kensington last year awarded two scholarships for research in connection with aëronautics. The students have held their scholarships at the National Physical Laboratory at Teddington. We learn from the *Times* of August 5 that an additional scholarship is now being offered for award at an early date by the governors of the college. The scholarship will be tenable for one year, and will consist of exemption from fees, together with a maintenance allowance at rates fixed with regard to the circumstances of the case, the value of the scholarship being not less than 50*l.* and not more than 150*l.* a year. It is open to any properly qualified individual, irrespective of residence or place of education. At Regent Street Polytechnic, too, the courses in aëro-engineering are to be developed. A second-year course of aërodynamics is being arranged for students who have qualified in the first year's work in aëro-engineering inaugurated during last session. The course will be open to other persons who can provide evidence that they possess the requisite knowledge of applied mathematics. Special instruction in workshop practice relating to aëroplanes and airships will be given, and students will receive help in making gliders and working models of different types of aërial craft they may be interested in.

THE calendar of the Edinburgh and East of Scotland College of Agriculture for 1910–11 provides full information as to the courses of instruction offered to pupils for the coming session. The college was founded in 1901 with the object of providing for agricultural education and research in the central and south-eastern counties of Scotland. Its classes are arranged in conjunction with certain classes in the science faculty of Edinburgh University. Courses for the diploma of the college and for the science degree of the University are concurrent. A short course, specially arranged to suit those who are actively engaged in farm work, is held at the college annually. The college also maintains a comprehensive scheme of extension work

in the neighbouring counties, and the services of its staff are placed at the disposal of farmers investigating new conditions or special points arising out of their farming operations. Under the regulations of the Scotch Education Department, the college is recognised as a central institution to which students may be sent by burgh and county education committees. Instruction in poultry-keeping has been considerably developed. The interest in school gardening grows, and seventy-three gardens have been laid out with the assistance of the college staff. The experiments and demonstrations carried on throughout the neighbouring district are described in the calendar, and give proof of the practical nature of the work undertaken.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, July 8.—Prof. H. L. Callendar, F.R.S., president, in the chair.—Prof. H. L. **Callendar**: The radio-balance: a thermoelectric balance for the absolute measurement of radiation; with applications to radium and its emanation. In this apparatus, which was first constructed in 1905, and was briefly described in an article on radiation contributed to the "Encyclopædia Britannica," heat supplied by radiation is directly compensated by the Peltier absorption of heat in a thermo-junction through which a measured electric current is passed. In the simplest form of the instrument, radiation admitted through a measured aperture, 2 mm. diam., falls on a small copper disc 3 mm. diam. by 0·5 mm. thick, to which two thermo-junctions are attached, forming a Peltier cross. One couple is connected to a sensitive galvanometer for indicating changes of temperature. The other is connected to a battery and rheostat in series with a millammeter or potentiometer for measuring the current required to reduce the deflection of the galvanometer to zero. In practice, two similar discs with similar connections are mounted side by side in a thick copper box, and are balanced against each other in order to avoid changes of zero due to exposure to sunshine, or rapid variations of temperature. The advantages of the disc radio-balance are that it is very simple to construct and easy to reproduce without material variation in the reduction constants. It is very suitable for measurements of solar radiation, or strong sources, but is insufficiently sensitive for weak sources; and the absorption coefficient a must be determined by comparison with a standard. In the cup radio-balance, the radiation is received in a copper cup 3 mm. diam. by 10 mm. deep, so that the absorption coefficient is practically equal to unity. Greater sensitiveness is secured by employing a pile of several couples, insulated from the cup, in place of the single balancing couple. External disturbances are eliminated by employing a pair of cups, similarly mounted but oppositely connected, enclosed in a thick copper cylinder. The Joule effect, represented by the C^2R term in the equation, is automatically eliminated by passing the same current in series through the opposing Peltier junctions soldered to the bottom of the cups. The cup exposed to radiation is cooled, and the cup screened from radiation is heated, by the Peltier effect, while both are equally heated by the Joule effect. A complete observation involves reversing the current and switching over the radiation screen, in order to eliminate any difference of sensitiveness of the two piles. By observing the neutral current, each cup can be used separately, as with the disc balance, but the disc balance cannot be used with the Peltier couples connected in opposition unless the balancing couples are insulated from the discs. The cup radio-balance is sensitive to less than a tenth of a micro-watt, and is very suitable for measuring the heat evolved by small quantities of radio-active substances. It was applied to radium at Prof. Strutt's suggestion, and Prof. Rutherford has kindly supplied samples of emanation, and has determined the value of the radium sample employed by comparison with his own standards. The second sample of emanation had only just come to hand, and the absolute values had not been finally reduced at the time the paper was read; but it appeared from the preliminary reductions that the heat evolution of radium in terms of Prof. Rutherford's standards was much greater than that given by previous observers.—Dr. A. **Russell**: The convection of heat from a body cooled by a stream of fluid. Attention is directed to certain deductions made by Boussinesq from the mathematical theory of the conduction of heat in liquids. Complete proofs are given of Boussinesq's formulæ, stress being laid on their limitations, and some of their practical applications are pointed out. It is proved that when a hot body is immersed in a stream of liquid flowing with constant velocity, the cooling is proportional to the difference of temperature between the body and the liquid. Newton proved experimentally in 1701 that this law was true for the case of a hot body being cooled by a draught of air. He enunciated his law with reference to the forced convection of heat from a body, and not, as is often stated, to the natural free convection from it. Lorenz has shown that in special cases the natural convection of heat will vary as the 1·25th power of the difference of temperature. Provided that the velocity of the cooling draught is kept constant between certain limits, Compan has shown that Newton's law is very approximately true even when the difference of temperature is as high as 300° C. Another deduction from the formulæ proved in the paper is that the cooling is very approximately proportional to the square root of the velocity of the convection current. The author gives the solution of the problem of the heating of a liquid flowing steadily, with a velocity less than the critical velocity, through a cylindrical tube which is maintained at constant temperature. It is shown that, in many practical cases, the heating power of the tube varies as $R\theta\sqrt{s\sigma k}Vl$, where R is the radius of the tube, θ the difference of temperature between the tube and the liquid, s the specific heat, σ the density, k the conductivity, V the velocity of flow, and l the length of the tube. It is proved that if a wire be immersed in a stream of liquid with its length at right angles to the direction of flow, the electric current which will fuse the wire varies as the 1·25th power of the diameter of the wire. Finally, the effect on the cooling of an electrically heated cylinder by a stream of liquid, of putting an insulating wrapping round it, is considered. It is shown that in certain cases the effect of this procedure is to lower the temperature of the cylinder, an effect which can be easily demonstrated experimentally. In order to simplify the mathematical work, only the case of incompressible fluids is considered. Experimental results, however, obtained by various physicists are quoted to show that some of the formulæ are approximately true for the cooling of heated bodies by convection with currents of air.—Prof. S. P. **Thompson**: Hysteresis loops and Lissajous's figures, and on the energy wasted in a hysteresis loop. Attempts have been made to find an explanation of the forms of the looped curves which express the hysteresis exhibited by iron and steel when subjected to cycles of magnetisation. Physical explanations to account for their general shape have been given by Ewing and Hopkinson, and M. Pierre Weiss has put forward an electronic theory to account for the principal features. The author shows that any hysteresis loop can be analysed into a harmonic series of closed curves corresponding to the various terms in the analysis of the current wave, and their constituents are examined in the paper. A number of examples of hysteresis loops were chosen and subjected to analysis. The loops chosen related to various kinds of iron and steel, hard and soft, solid and laminated, and taken by various methods. In carrying out the analysis, the simple approximate method described by the author (Proc. Phys. Soc., vol. xiv.) was used. Details are given of the analysis of various loops, the effect of eddy currents on the size and form of the loops is discussed, and an account is given of the effect of the higher sine and cosine constituents of the current wave.—Dr. W. H. **Eccles**: The energy relations of certain detectors used in wireless telegraphy. The paper is a record of the results of an experimental examination into the physical properties of the electrolytic detector, the zincite rectifier, the carborundum rectifier, and a thermoelectric detector consisting of a light contact between graphite and galena. The conditions of the experiments have been generally identical with those arising in the ordinary employment of the detectors, and, in particular, the quantities of energy given to the instruments, in the

form of electrical oscillations, have been of the same order in these experiments as in actual practice. The chief fact brought to light is that the power curves of all the detectors are straight lines, which suggests that all the detectors are fundamentally thermal in their action.

PARIS.

Academy of Sciences, August 1—M. Émile Picard in the chair.—M. **Bassot**: The geodesic expedition to the equator. A description of the first two volumes dealing with the results of the expedition under Col. Bourgeois for measuring the arc of the meridian at Quito.—A. **Gautier** and P. **Clausmann**: The action of mixtures of carbon monoxide and hydrogen, or of carbon dioxide and hydrogen, upon the oxides of iron. Carbon monoxide and hydrogen with Fe_3O_4 at 500° C. gave a mixture of ferrous oxide and a carbide of iron, the latter corresponding to the composition $Fe_{12}C$. The bearing of the results on the composition of the gases issuing from fumerolles is discussed.—Paul **Sabatier** and A. **Mailhe**: The catalytic preparation of alkyl-aryl ethers. A mixture of methyl alcohol and phenol vapours passed over thoria at 390°–420° gives a good yield of anisol, $C_6H_5.O.CH_3$. If the phenol is replaced by its higher homologues, the corresponding homologues of anisol are obtained, and the substitution of ethyl alcohol for the methyl alcohol gives $C_6H_5.O.C_2H_5$ and its homologues, some unsaturated hydrocarbon being produced by a secondary reaction between the ethyl alcohol and the thoria.—M. **Schwœrer**: The thermal phenomena of the atmosphere.—G. **Gaiffe**: A method of stereoscopic and kinematographic radiography.—E. M. **Antoniadi**, F. **Baldet**, and F. **Quénisset**: The occultation of η Gemini by the planet Venus. Observations made at the Juvisy Observatory on July 26. The duration of the occultation was 3m. 30s. ±2·5s. The variations in the luminosity of the star when approaching contact lead to 80 to 110 kilometres as the height of the atmosphere of Venus.—José Comas **Solà**: The discovery of a small planet, presumably new. This was found on a photograph of Halley's comet, taken on June 6 last.—José Comas **Solà**: Study of Halley's comet.—M. **Coggia**: The occultation of η Gemini by Venus, observed at Marseilles.—Th. **de Donder**: Poisson's theorem and the differential invariants of Lie.—Paul **Lévy**: Some equations defining line functions.—Harald **Bohr**: The convergence of Dirichlet's series.—A. **Sainte-Laguë**: Proportional representation and the method of least squares.—William **Duane**: The evolution of heat in a mixture of radium and a phosphorescent salt. The rate of evolution of heat by a radium salt is not affected by admixture with a phosphorescent substance.—Pierre **Jolibois**: The relations between white phosphorus, red phosphorus, and pyromorphic phosphorus. By a study of the vapour pressures, the author concludes that these three varieties of phosphorus are distinct, and criticises the theory recently proposed by Cohen and Olie.—Henri **Leroux**: The heats of combustion of some hydronaphthalene derivatives.—Ed. **Chauvenet**: The combinations of thorium chloride with ammonia.—Georges **Charpy**: Behaviour of steel analogous to the "tin disease." A study of the conditions leading to an increase of the velocity of crystallisation in steel on annealing.—J. B. **Senderens**: Catalytic reactions in the wet way based on the use of aluminium sulphate. In the preparation of ethylene by the interaction of alcohol and sulphuric acid, the presence of aluminium sulphate lowers the temperature of the reaction and increases the velocity of evolution of the gas. The same salt also possesses a favourable catalytic effect in the preparation of ether.—Daniel **Berthelot** and Henry **Gaudechon**: The mechanism of photochemical reactions and the formation of plant principles: the decomposition of sugar solutions. The mechanism of the reactions caused by exposure to ultra-violet rays is analogous to that in living plants. Exposed to these rays, solutions of glucose give carbon monoxide, dioxide, methane, and hydrogen. Levulose, maltose, and saccharose behave similarly, but the proportions of the gases are different in each case.—André **Piedallu**: A new mould in oil tanning.—Henri **Labbé**: Contribution to the study of nitrogenous exchanges.—Gabriel **Bertrand** and A. **Compton**: The individuality of cellase and emulsin. Comparative experiments on the hydrolysis of cellose by cellase and of amygdalin by emulsin show that these two diastases are quite distinct.—N. A. **Barbieri**: The non-existence of free or combined lecithins in yolk of egg.—Etienne **Sergent** and Edmond **Sergent**: Immunity against malaria in birds. Conservation *in vitro* of the sporozoïtes of *Plasmodium relictum*. Relative immunity obtained by inoculation with these sporozoïtes.—B. **Brunhes**: Telluric currents.

NEW SOUTH WALES.

Linnean Society, June 29.—Mr. C. Hedley, president, in the chair.—R. J. **Tillyard**: Monograph of the genus Synthemis (Neuroptera: Odonata). The most important points discussed are:—(1) The position of the genus in the subfamily Corduliinæ. The view is put forward that it should be separated from the Macromina, so as to constitute a subgroup Synthemina. (2) Subdivision of the genus itself.—T. G. **Sloane**: Studies in Australian entomology. No. 16. New species of Carabidæ. A new genus, Stichonotus, referable to the subfamily Carabinæ, and eighteen species belonging to the subfamily Harpalinæ, are described as new, including a species of the Asiatic genus Holcoderus, now first recorded from Australia.—W. W. **Froggatt**: The entomological fauna of Narru Island, of the Ocean Island group.—A. H. **Hamilton**: Description of a new species of Lepidosperma (Cyperaceæ) from the Port Jackson district, with some miscellaneous botanical notes.

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